Palethnologie
Archéologie et sciences humaines

10 | 2019
L'acquisition et le traitement des matières végétales et animales par les néandertaliens : quelles modalités et quelles stratégies ?

The practices used by the Neanderthals in the aquisition and exploitation of plant and animal resources and the function of the sites studied: summary and discussion

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Electronic version
URL: http://journals.openedition.org/palethnologie/4179
DOI: 10.4000/palethnologie.4179
ISSN: 2108-6532

Publisher
Presses universitaires du Midi

Electronic reference
Émilie Claud, Céline Thiébaut, Sandrine Costamagno, Marianne Deschamps, Marie-Cécile Soulier, Michel Brenet, Maria Gema Chacón-Navarro, David Colonge, Aude Coudenneau, Cristina Lemorini, Vincent Mourre and Flavia Venditti, « The practices used by the Neanderthals in the aquisition and exploitation of plant and animal resources and the function of the sites studied: summary and discussion », *Palethnologie* [Online], 10 | 2019, Online since 01 November 2019, connection on 14 March 2020. URL : http://journals.openedition.org/palethnologie/4179 ; DOI : https://doi.org/10.4000/palethnologie.4179

CHAPTER 4

The practices used by the Neanderthals in the aquisition and exploitation of plant and animal resources and the function of the sites studied: summary and discussion

(C. Thiébaut, É. Claud, S. Costamagno)

The pooling of data from use-wear studies on the lithic industries with that obtained from the study of the faunal remains allows us to contribute to the discussion and offer certain answers to the following questions:

- Is the frequency of the activities identified by use-wear analysis an archaeological reality or is it the result of a methodological bias?
- What were the practices used by Neanderthals in exploiting plant and animal resources?
- Is it possible to identify any specializations in terms of tools?
- What interpretations can be proposed regarding the function of the sites studied?

This summary and discussion chapter is based on the use-wear data obtained for 492 active areas, focusing on animal and plant material (tables 49-50). We did not include the 119 active areas used on mineral material or the pieces for which it was not possible to establish a clear interpretation of function. It should be reminded that for a relatively high proportion of the active areas (67 areas, i.e. 13.5 %), the precise activity could not be determined. For the lithic use-wear analysis, the interpretations of activity are therefore based on 424 active areas.

In terms of the fauna, the data concerns only two sites (Les Pradelles, Grotte du Noisetier) at which it was possible to identify, thanks to the precise recording of cutmarks, different butchery operations (skinning, dismembering, defleshing, tongue removal, disarticulation, and tendon removal), the interpretation of which is based on the synthesis of currently available data produced as part of this monograph[1] (Annex 4). At Les Pradelles, the sample size has allowed us to discuss the degree of recurrence of butchery gestures. At Grotte du Noisetier, the qualitative approach was accompanied by a quantitative approach. In parallel, micromorphological studies were carried out on the defleshing cutmarks present on the long bones at Grotte du Noisetier in order to document the possible use of denticulates as a cutting tool, these tools being, at present, the only tools observed to leave characteristic marks (figure 170).

The use-wear studies available for other sites, whether on lithic remains or faunal remains, have also been taken into account in order to enrich our thinking and thus allow us to propose a more precise overview of the methods of acquisition and transformation of plant and animal resources employed by the Neanderthals of Western Europe.

1. An initial overview based on three carcasses (Costamagno, 2012) followed by an overview of the nine red deer carcasses, but involving only the appendicular skeleton (Soulier, Costamagno, 2017), have been previously published.

1 - The representativity of the working of animal material and wood in our corpus of tools: a methodological bias or an archaeological reality?

(É. Claud, C. Thiébaut, S. Costamagno, M. Brenet, M. Deschamps, V. Mourre)

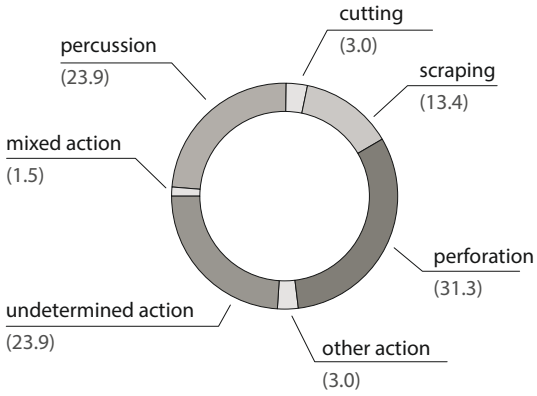
The use-wear studies on the stone tools have demonstrated the working of different materials (table 51, figure 211) such as wood, hide, and hard animal material, as well as butchery activities. The working of animal material clearly dominates our corpus as it involves a total of 356 active areas, i.e. 72.5 % of the areas for which an activity has been proposed, whereas woodworking has only been clearly identified on 68 active areas, i.e. 14 % of the areas (16 % of the zones for which an activity was proposed). For seven of the 17 sites included in our study, no tools related to woodworking have been documented. For four sites, however, the lithic assemblages benefitted from a use-wear analysis involving only a limited number of very specific pieces (Abri Olha II, Bayonne le Prissé PM2, Combe Brune 2, and La Conne de Bergerac, see table 47). The frequency of traces attributed to woodworking or the working of a medium-hard material that could potentially be wood were very low on the sites that were subject to a comprehensive analysis, with the exception of the assemblage at Coudoulous, and, to a lesser extent, Mauran (table 57).

Collections	Number of active zones related to woodworking	Total number of active zones	Frequency (%)
Bayonne le Prissé (PM1)	0	10	0
Bayonne le Prissé (PM2)	0	5	0
Chez-Pinaud (US 06/07)	8	170	4.7
Coudoulous (layer 4)	21	64	32.8
Fonseigner (Dsup)	2	46	4.3
Grotte du Noisetier	0	21	0
Les Fieux (layer K)	7	52	13.5
Mauran (XV 2 / layer 2)	10	57	17.5
Saint-Césaire (level Egpf)	0	27	0

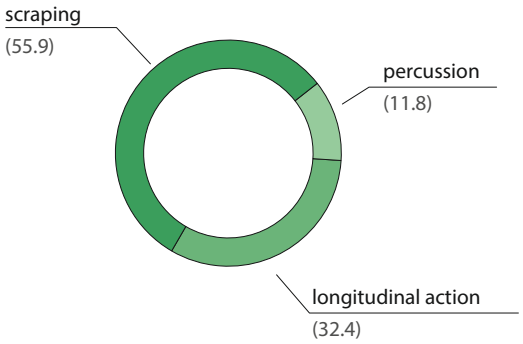
Table 57 - Number of active zones interpreted as having been used to work wood and the frequency of this activity according to the assemblages studied (including only those assemblages subjected to complete analyses).

On the sites where the faunal remains have been preserved, the carcasses have most often been intensively exploited. Although sometimes non-exhaustive (Mauran, Coudoulous 1), the exploitation of marrow is the most well-documented butchery activity, since almost all the bones with a medullary cavity have been fractured by humans. This removal of grease is so intense that it sometimes continues into the spongy tissue (Grotte du Noisetier, Les Pradelles). The poor state of preservation of the bone surfaces at some sites (Les Fieux, Coudoulous 1, Mauran) has prevented the reconstruction of the different activities carried out by the Neanderthals, while in other cases (Payre, Chez-Pinaud, Saint-Césaire, Gatzarria, Abri Olha II), the zooarchaeological analyses are too succinct to allow the documenting of all the butchery operations that were potentially carried out (table 71). At all the sites, the question of the disarticulation of the carcasses is particularly difficult to assess, as the articular extremities are under-represented or absent. The scarcity of the post-cranial axial skeleton notably prevented the documenting of any potential projectile impact marks or percussion marks related to the segmentation of the axial skeleton.

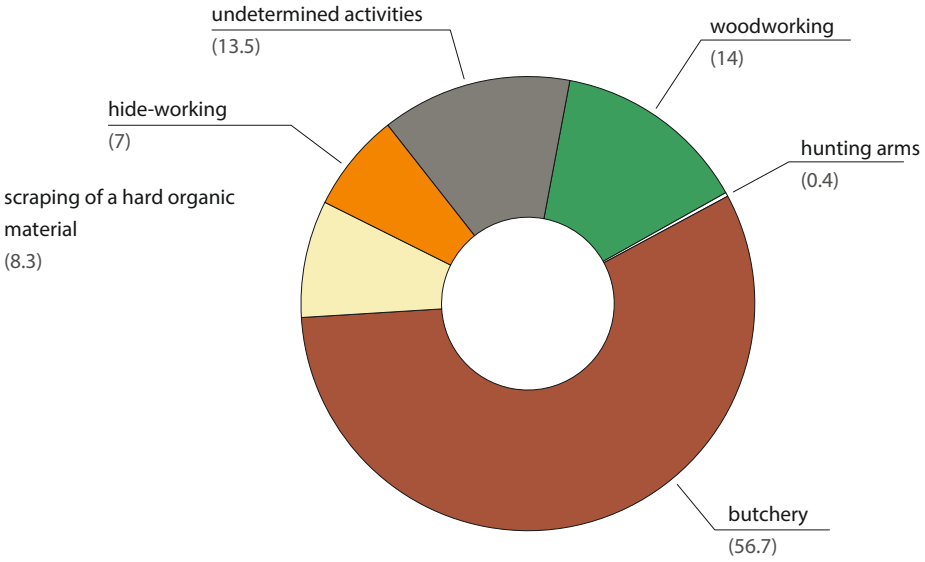
Although the scarcity or absence of traces related to the working of certain materials (non-woody plants, antlers, bones, and shells) is consistent with the large majority of results obtained for the other sites of the Middle Palaeolithic, the low frequency of traces related to woodworking



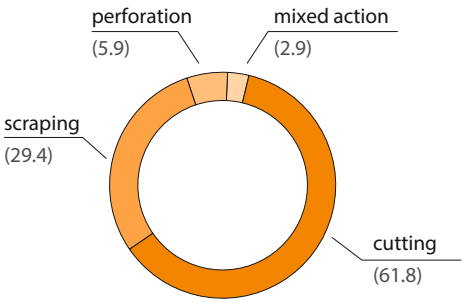
Modes of action of undetermined activities (%)



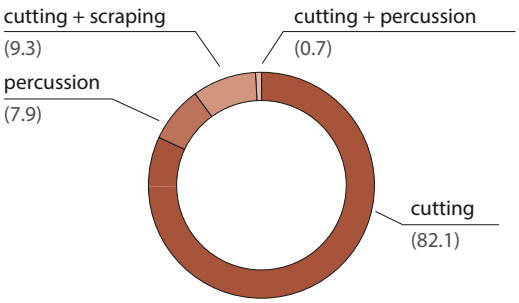
Modes of action identified in woodworking (%)



Identified activities (%)



Modes of action identified in hide working (%).



Modes of action identified in butchery (%).

Figure 211 - Illustration of the frequency of the activities identified by use-wear analyses, representing the modes of action for each activity.

in our study contrasts sharply with the results of the analyses carried out in the 1980s and 1990s, in which traces related to woodworking were predominant (Anderson-Gerfaud, 1981; Beyries, Boëda, 1983; Beyries, 1987a, 1988b, 1993; Beyries, Hayden, 1993; see figure 3; Part I, chapter 1.1). It is worth considering the reasons for this difference in results.

The assemblages studied in the 1980s and 1990s and those making up our corpus include sites whose occupations were related to different functions and environments (see Part II, chapter 1 and Claud, 2004 for a synthesis of the older studies), so this divergence cannot be explained by these two factors. It therefore seems to us that problems of preservation of use-wear traces, differential conservation of use-wear traces, and differences in the methodologies used (preferred scales of observation) could explain this divergence in results.

A - Macro-traces

Our study corpus included several assemblages in a state that did not allow the preservation of any micro-traces (table 47). Thus, with the exception of three assemblages (Chez-Pinaud, Fonseigner and Coudoulous), interpretations of function were mainly based on the analysis of macroscopic use-wear traces (n=57 for the working of medium-hard material such as wood and n=205 for butchery). Could macroscopic traces produced by woodworking be underestimated in our study? Two phenomena could have lead to an underestimation of these traces: their poor preservation and their morphometric convergence with those produced by the working of other materials.

Firstly in terms of the degree of fragility of macroscopic traces related to woodworking, edge damage produced by the different actions involved (planing, sawing, scraping, bark stripping, ...), have proven, for an equivalent duration of work, more abundant and of equivalent size, if not larger, than the edge damage produced during butchery. There is therefore no reason why these traces should not preserve as well.

The macroscopic traces on flint due to woodworking seem to us sufficiently characteristic and diagnostic to be identified as such or at least suspected as such (possible working of medium-hard material), even if it is true that very occasionally experimental pieces, notably retouched ones such as bifaces or denticulates, used on green wood, present no macro-traces at all (see Part I, chapters 2.7 and 10). It should also be kept in mind that the absence of macroscopic traces is not unique to woodworking as this has also been observed on experimental denticulates used in butchery and for the working of soft materials such as hide (see Part I, chapter 2.11).

On the quartzite tools, however, edge damage associated with woodworking are sometimes more discreet, and less easily readable and distinguishable from natural alterations (see Part I, chapter 2.6). They could therefore have been underestimated in these cases. In addition, as wood scraping and bone scraping can sometimes produce similar macroscopic traces (in particular on quartzites), we should not exclude the possibility that some of the pieces interpreted as having scraped hard organic material, such as bones, were in fact used for woodworking. The sixteen pieces used for percussion on medium-hard or hard materials for which no activity has been determined (table 51, figure 211) are flake cleavers, some of which could have been used for acquiring wood.

In addition, the scraping of very hard wood or fire-hardened wood produces scarring, even on flint, whose intensity and morphology is comparable to that observed during the scraping of bone material. Thus, some of the pieces presenting no micro-polish, identified as having scraped a hard organic material such as bone, could equally be tools that scraped very hard wood or fire-hardened wood. Nevertheless, even if we add all these active areas (used for scraping and percussion) to the corpus of areas recognized as having worked medium-hard materials such as wood, the proportional difference between woodworking and the working of animal material remains very high (125 active areas for wood, versus 315 for animal material). If we then go further, by hypothesizing

that all the active areas for which an activity could not be identified (n=67, see table 51) and all the pieces that were used to scrape a hard, bone-type material (n=41) were in fact used for woodworking – which is highly unlikely – we obain a total of 176 pieces for woodworking, which still remains well below the number of tools dedicated to the working of animal material.

In view of these different elements, it is difficult to imagine that the absence or scarcity of edge damage related to woodworking is simply due to problems of preservation or morphological convergence. On the contrary, it is the other activities such as the working of soft animal material (cutting of meat or hide for example), which sometimes leave tenuous macroscopic traces, that are likely to have been underestimated in our study.

B - Micro-traces

In the 1980s, use-wear analysis were almost exclusively based on micro-polishes and not on macro-traces. Since polishes produced by woodworking are more resistant to alkaline attack than those produced by butchery or the working of hide (Plisson, Mauger, 1988), it is possible that the poor preservation of butchery polishes led to an overestimation of woodworking, as anticipated at the time by S. Beyries (1987a). This overestimation could also have been fueled by the existence of morphological convergences between wood polishes and ice polishes, caused by friction with frozen sediment or the use of tools to work ice in periglacial environments (Caspar *et al.*, 2003). It is thus essential to analyze the distribution of polish over the entire surface and edges of the studied pieces in order to distinguish natural origins from functional ones. In the case of a natural origin, problems of convergence should therefore be overcome, but if the pieces were used to retrieve or work ice, the distinction from those used on wood can be more delicate. On this basis, some researchers appear to question the validity of the results of early use-wear studies of the Middle Palaeolithic (Caspar *et al.*, 2003).

Amongst the assemblages in our corpus on which micro-traces have been preserved, in two cases out of three no micro-polish related to woodworking was observed (Chez-Pinaud, Fonseigner), whereas those related to the working of soft animal material, which is considered more fragile (Plisson, Mauger, 1988), are numerous. The 119 areas with micro-traces are mostly cutting edges used in butchery (n=74) followed by hide working (n=34). Only at Coudoulous, on eleven active areas, were micro-traces observed which were interpreted as related to woodworking. This data appears to corroborate the fact that the scarcity of traces related to woodworking is not due to preservation or recognition issues. Thus, the differences in the frequency of woodworking between our corpus and the collections analyzed in the 1980s could be due to a slight underestimation of the tools used for woodworking on our part (particularly in the case of quartzites), coupled with their likely overestimation in the 1980s, due to the fragility of micro-polish due to the working of soft animal material, and problems of taphonomic convergence.

In addition, more recent studies, which have made complementary use of low and high magnifications, also illustrate a high frequency of butchery traces in several collections: Abri du Musée (Dordogne, Lemorini, 1998), Les Tares (Geneste, Plisson, 1996), La Combette (layer A/B1, Vaucluse, Lemorini, 2000), Grotta Breuil (layer 6, Italie, Lemorini, 2000), Bettencourt-Saint-Ouen (Somme, Locht *et al.*, 2002), El Salt (Spain, Rodríguez Rodríguez *et al.*, 2002), Abric Romaní (Catalonia, Martinez-Molina, 2005, 2008; Martinez *et al.*, 2005), Champ-Grand (Loire, Araujo-Igreja, 2008), La Mouline (Dordogne, Pasquini, 2008), Bajondillo Cave (Spain, Cortés Sánchez *et al.*, 2011b), Jonzac or Chez-Pinaud[2] (US 22, Charente, Claud *et al.*, 2012), and Havrincourt "Les Bosquets" (Goval *et al.*, 2013, 2015).

2. Jonzac and Chez-Pinaud are the same site, Chez-Pinaud being the place name, and Jonzac the name of the commune (Jaubert *et al.*, 2008).

They also attest to the somewhat rarer existence of collections involving a high proportion of pieces used for woodworking, which were sufficiently well preserved to present micro-polishes, such as at Sesselfelsgrotte (Germany, Rots, 2009) and San Quirce (Castile and Léon, Clemente-Conte *et al.*, 2012). These studies show that the difference in the frequency of traces related to woodworking can be observed independently of methodological or taphonomic issues, probably in relation to the activities carried out by the Neanderthals according to the different types of occupation of the sites. Despite the scarcity of traces related to woodworking, our study has nonetheless revealed several new elements on the methods of acquisition and exploitation of this material by Neanderthals.

2 - Neanderthal approaches to the acquisition and use of plant

(É. Claud, C. Thiébaut, M. Brenet, M. Deschamps, V. Mourre, M.-G. Chacón-Navarro)

The practices that we have identified in this study with regard to the acquisition and use of fibrous materials represent a limited set amongst a much broader range of potential behaviours, and do not represent an exhaustive account of prehistoric realities. The acquisition of wood or any other plant material could entail a number of different practices that could vary according to environment, the needs and habits of a group, and would not necessarily require the use of stone tools (Théry-Parisot, 2001). Because tools in organic materials were not preserved at the study sites, we are deprived of a vast source of information that could have enriched our analysis. What is more, neither the species nor the freshness of the wood could be determined by use-wear analyses, given the absence of residues and the extreme rarity of micro-polish. Similarly, though a range of different actions may be recorded in archaeological objects, we were not able to document specific gestures (positive or negative rake angle, for example) or identify specific goals (peeling, planing, sharpening, segmenting, ...). In order to discuss Neanderthal practices in the acquisition and exploitation of wood, the primary sources of information are traces of use and hafting on stone tools, and the morpho-technological characteristics of the tools dedicated to woodworking, along with our experimental observations on the effectiveness of specific tools in certain tasks.

A - Current use-wear data

A specific activity was proposed for 424 active zones on stone tools. Amongst these, 68 active zones, or only 16 %, bear traces indicative of woodworking. Three modes of action were identified: percussive action, longitudinal action, and transverse action (table 51). These probably correspond to different goals (chopping, pruning, sawing, grooving, shaping by planing, scraping, ...).

Transverse action, by which we mean scraping, dominates (n=38, see figure 211), followed by longitudinal action (n=22), while percussion is poorly represented (n=8). This last figure must be qualified, as there are a number (n=16) of active zones that were used for percussion on medium-hard or hard organic materials that could have been wood or bone. Percussion on wood could therefore be underestimated in the study assemblages, specifically amongst the set of flake cleavers on which such actions could be determined: Abri Olha I and II, El Castillo and Gatzarria.

Perforation of wood could not be identified with certainty. However, the perforation of medium-hard, or medium-hard to hard materials was identified on objects from Mauran, Les Fieux and Payre (tables 48-49), and could indicate perforation of wood or of dry rawhide.

If the longitudinal actions on wood can be considered representative of an archaeological reality, perforation, planing / scraping, and percussion, in contrast, may be under-estimated due to the morphological overlap in the macro-traces associated with working both wood and other hard materials like bone (scraping and percussion) or semi-rigid materials like dry raw hide (perforation and scraping).

B - Percussion: a mode of action used for acquisition?

Evidence of direct percussion on medium-hard materials like wood was observed on eight pieces in the Vasconian assemblages from El Castillo, Gatzarria, Abri Olha I, and the sites of La Graulet and Chez-Pinaud. These tools are primarily large tools, five flake cleavers in quartzite and ophite and two flint bifaces with transverse cutting edge, as well as a single flint side scraper (figures 212-213, table 58). The active zones of identified tools are unmodified on the flake cleaver and the side scraper, and retouched on the bifaces. Their morphometric characteristics are difficult to describe because they have been heavily modified by use, in terms of outline, profile, or section. The angle of the cutting-edge could nonetheless be measured on the un-chipped portions of certain pieces. On three flake cleavers, these angles were measured at 45°, 50°, and 55°. The raw edge of the side scraper had an average angle of 29°, compared to the 40° and 45° determined for the bifaces. On the flake cleavers and the bifaces, the scars present characteristics and dimensions similar to those observed on experimental tools that had been hafted for felling trees, which suggests their use in this activity. They could have also been used in the segmenting of trees that had already been felled, or had fallen naturally. The morphology of the massive tools with distal transverse cutting-edges lends itself well to the activities of felling and segmenting. On the side scraper, used on its unmodified edge, the scarring is less developed and comparable to that observed on experimental flakes used in percussion, hafted or un-hafted, in work at a smaller scale, such as the removal of branches or the trimming of a trunk. In this case, it is impossible to be more precise with regard to the intent of the artisan: the acquisition of a branch or the shaping of a blank.

C - Longitudinal actions: modes of acquisition or of transformation?

The 22 active zones on which a longitudinal gesture was identified were primarily on flakes with unmodified edges in quartz or quartzite at Coudoulous (n=8) and in flint at Payre (n=6), Chez-Pinaud (n=2), and Les Fieux (n=1). In contrast, at the sites of Mauran and Fonseigner, this action was identified on retouched tools: denticulates in flint and quartzite at Mauran (n=4) and the unmodified edge of a single flint side scraper at Fonseigner (Annex 5, table 58, figure 214). Their small number, at each individual site and cumulatively, does not allow us to identify any clear trends in morphology of the active zones (angle, outline, ...).

D - Shaping or maintenance of wooden objects by scraping

Traces of transverse action are the most numerous amongst the pieces that were identified tools for working medium-hard materials like wood. They were observed on 38 active zones, in six assemblages with different technological characteristics (Chez-Pinaud, Coudoulous, Fonseigner, Les Fieux, Mauran, Payre). Tools of this type are very diverse: unmodified flakes on quartz, quartzite, or flint; pseudo-Levallois points in flint, side scrapers in flint, quartz or quartzite, and notched denticulates (table 58, figures 215-216). As a result, the active zones are fairly variable: unmodified and retouched edges with morphologies that are sometimes convex but more frequently rectilinear or concave and edge angles that range from very low to high. The active zones are often restricted, indicating a relatively narrow working edge.

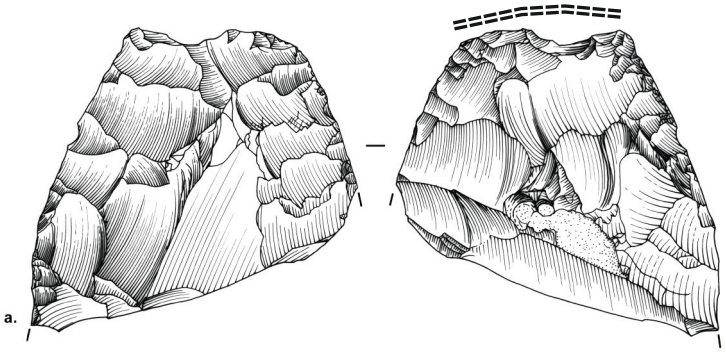
This mode of action is clearly linked to the transformation of blanks at sites that are interpreted as living-sites but also as sites dedicated to the acquisition of large bovids (see Part II, chapter 4.5). The extreme rarity of micro-polish does not permit us to identify the state of the wood that was worked (green or dry) or to determine the rake angle used (see Gassin *et al.*, 2013, negative or positive).

Abri Olha I
(photographs: EC)
Flake cleaver no. 2806, ophite
use: percussion against a medium-hard organic material

El Castillo
(photographs: EC)
Flake cleaver A225
use: percussion against a medium-hard organic material

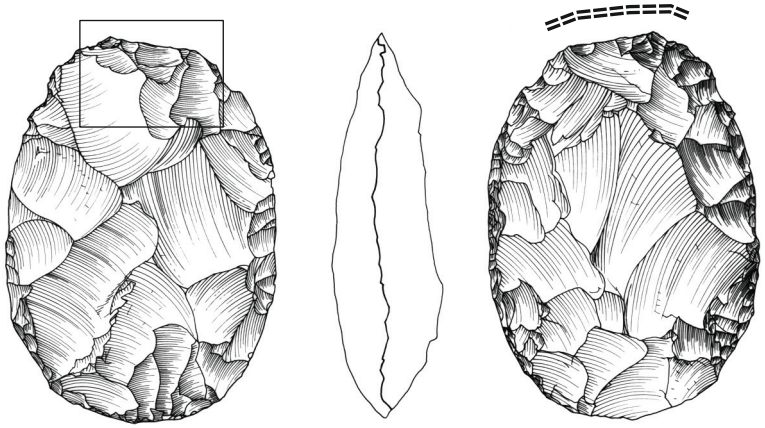
Figure 212 - Flake cleavers from Abri Olha I and El Castillo used in percussion against a medium-hard material, probably in the context of woodworking. The black rectangles indicate the locations of the photographs of the use-wear traces presented in figure 180[a,f] (CAD: É. Claud and M. Coutureau).

La Conne de Bergerac
(drawings: F. Brenet)
Z2, 2132, flint
use: scarring of undetermined origin
(percussion against a medium-hard material?)



1 cm

La Graulet
(drawings: F. Brenet)
Z3, Bds 1047, flint
use: percussion against a medium-hard material



1 cm

Chez-Pinaud
(photograph: EC)
D16 912, flint
use: percussion against a medium-hard material

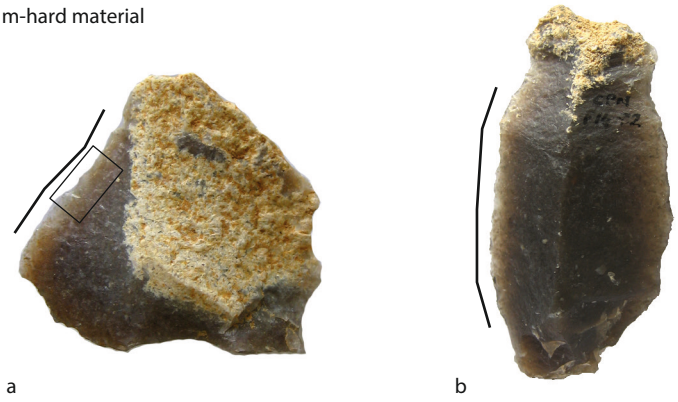
1 cm

Figure 213 - Bifaces and side scrapers from La Conne de Bergerac, La Graulet and Chez-Pinaud, possibly (La Conne de Bergerac) or certainly (La Graulet, Chez-Pinaud) used in percussion against a medium-hard material, probably in the context of woodworking. The black rectangles indicate the locations of the photographs of the use-wear traces presented in figures 180[b] and 181[b] (CAD: É. Claud and M. Coutureau).

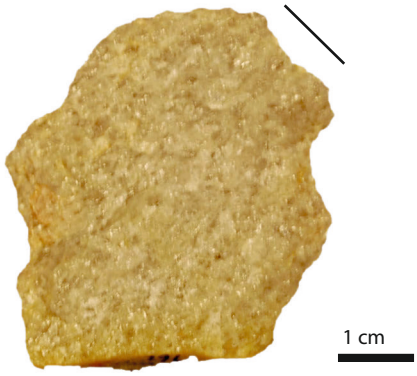
	Wood processing					Animal material processing											Undetermined activities									
	Woodworking (longitudinal motions)	Probable woodworking (longitudinal motions)	Woodworking (scraping)	Probable woodworking (scraping)	Probable woodworking (percussion)	Hunting points	Butchery / cutting (+ scraping at Coudoulous)	Probable butchery (cutting)	Butchery, cutting (non micro-polish)	Probable heavy butchery (cutting)	Probable heavy butchery (percussion)	Probable butchery (cutting + percussion)	Hide working (cutting)	Hide working (scraping)	Probable hide working (piercing)	Hide working / mixed action (cutting + scraping)	Scraping of a hard and organic material (bone?)	Undetermined activity (cutting)	Undetermined activity (scraping)	Undetermined activity (piercing)	Undetermined activity (intermediate piece)	Undetermined activity (percussion)	Undetermined activity (mixed motion)	Undetermined activity / undetermined motion	Hafting scars	Hide wrapping	**Total**
UNRETOUCHED FLAKES	4	10	4	13			33	41	23	2	1	1	5	3			11	1	4	14	1	1		9		1	182
NATURAL AND RETOUCHED BACKED KNIVES	1	1		3			4	2	1		1	1					1							1			16
CORE EDGE FLAKES								4				2		1			1		2					1			11
FLAKES WITH ABRUPT AND MARGINAL RETOUCH								1	1																		2
LEVALLOIS POINTS							1		1																		2
PSEUDO-LEVALLOIS POINTS				6		1?	2	10	3						2		1		1	3				1			29
MOUSTERIAN POINTS							2	1					1												2 ?		4
TRIANGULAR FLAKES						2																					2
DENTICULATES		4		3			1	21	4			2					5			2							42
CLACTONIAN NOTCHES				1				1		1		1					5	1	1	1							12
RETOUCHED NOTCHES																	1										1
PSEUDO-DENTICULATES																											0
SCRAPERS		1	2	4	1	1?	12	13	6	2		1	11	6		1	7		1		1			2	2 ?		71
SCRAPERS ON BIFACE MANUFACTURING FLAKE							1	3	1																		5
RETOUCHED FLAKES				1		2?		2									4			1							8
CLEAVERS					5							13										15					33
BIFACES					2		13	6	6				4				1						1				33
ENDSCRAPERS								1	1								3										5
COMPOSITE TOOLS				1																							1
BEC												1															1
LIMACE									1																		1
CORES																											0
BIFACE MANUFACTURING FLAKES		1					5	2	16	1							1							3			29
RESHARPENING AND NOTCHING FLAKES								3																			3
Total of active zones	**5**	**17**	**6**	**32**	**8**	**2 + 4?**	**74**	**111**	**64**	**6**	**2**	**22**	**21**	**10**	**2**	**1**	**41**	**2**	**9**	**21**	**2**	**16**	**1**	**17**			**492**
Total of active zones per activity	**68**					**2**	**279**						**34**				**41**	**68**						**-**		**492**

Table 58 - Number of active zones by type of piece bearing traces of use according to the activities identified (excluding traces of undetermined origin and zones used on mineral materials).

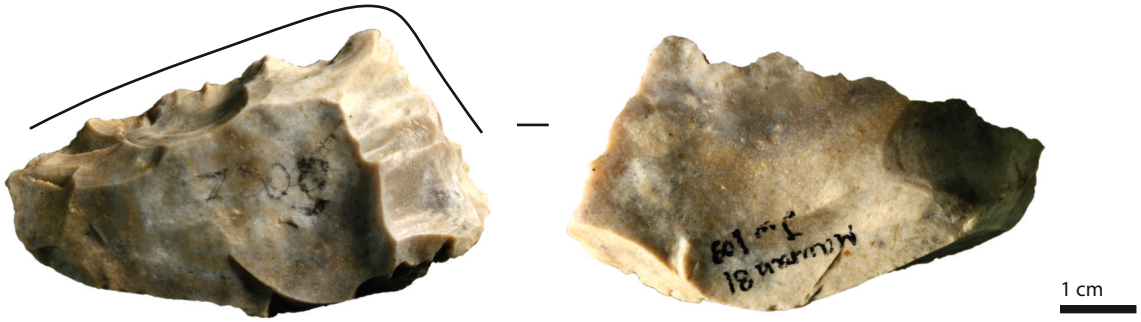
Chez-Pinaud
(photographs: EC)
a - CPN E16 677, flint
b - F14 72, flint
use: longitudinal action on a medium-hard material



Coudoulous
(photograph: FV)
Cs 79 Ext H8 c4n4 5162, quartz
use: sawing dry wood



Mauran
(photographs: CT)
M 81 JW 109, flint
use: sawing a medium-hard material



Les Fieux
(photographs: CT)
K30795, quartzite
use: perforation of a medium-hard
to hard material (wood?)

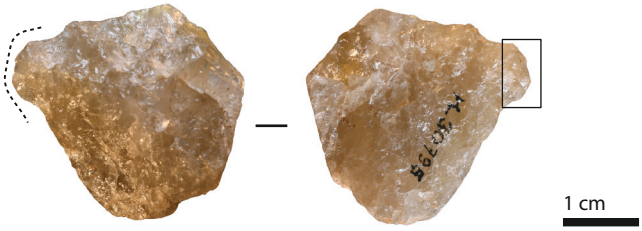
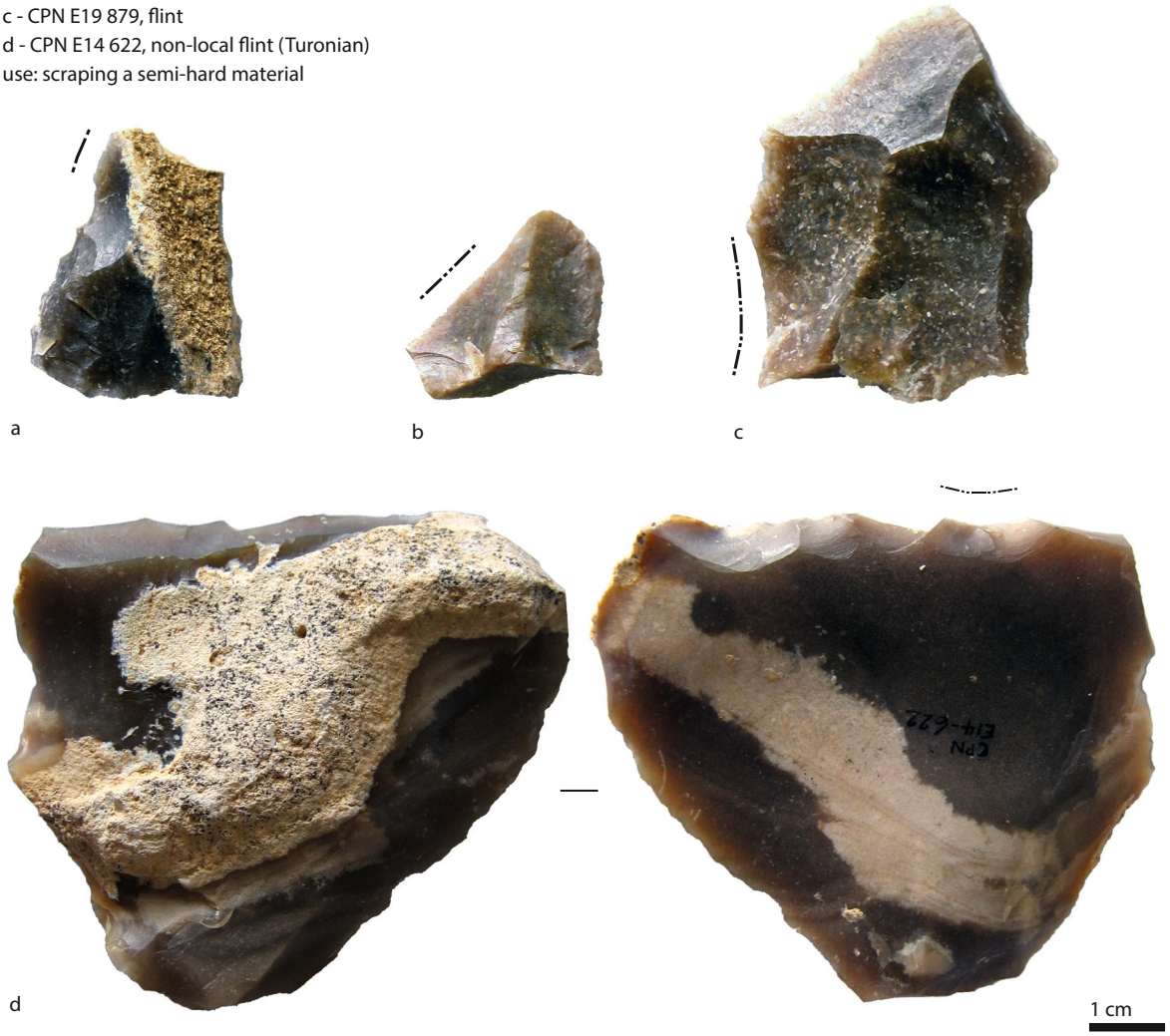


Figure 214 - Unmodified flakes and denticulates from the sites of Chez-Pinaud, Coudoulous, Mauran and Les Fieux, used or probably used in the context of woodworking, in longitudinal actions and perforation. The black rectangles indicate the locations of the photographs of the use-wear traces presented figures 180[c] and 181[c] (CAD: É. Claud and M. Coutureau).

Chez-Pinaud
(photographs: EC)
a - CPN E19 631, flint
b - CPN E14 194, flint
c - CPN E19 879, flint
d - CPN E14 622, non-local flint (Turonian)
use: scraping a semi-hard material



Fonseigner
(photograph: EC)
Fons Z3 Dsup 33, flint
use: scraping a semi-hard material

Coudoulous
(photograph: FV)
COU 79 4 2050, quartz
use: scraping of green wood

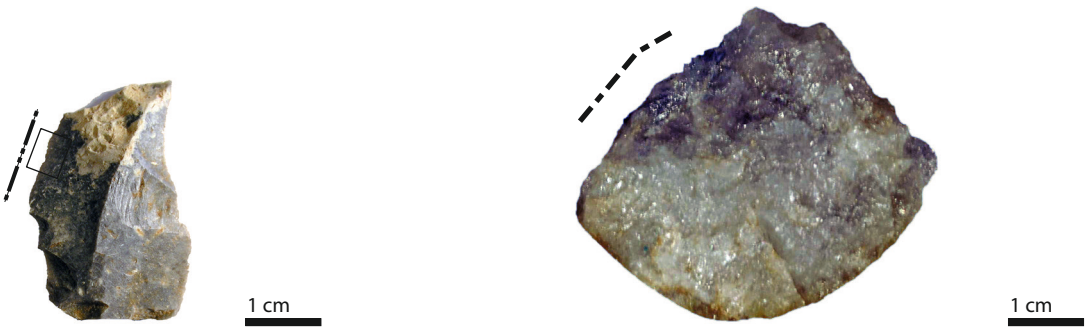
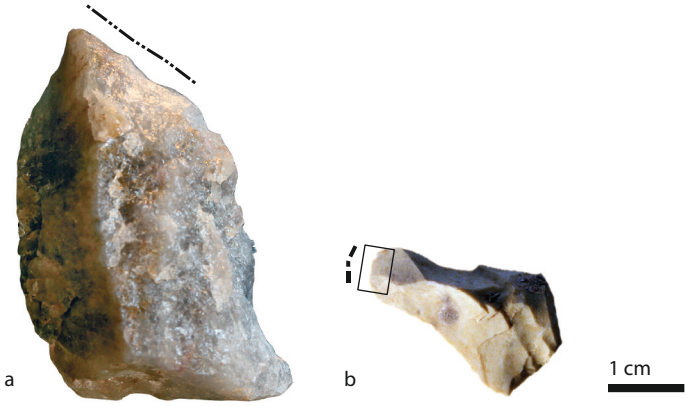


Figure 215 - Unmodified flakes and denticulates from the sites of Chez-Pinaud, Fonseigner and Coudoulous, used or probably used in the context of woodworking, used to scrape a medium-hard material or material identified as green wood (Coudoulous). The black rectangles indicate the locations of the photographs of the use-wear traces presented in figure 181[a] (CAD: É. Claud and M. Coutureau).

Les Fieux
(photographs: CT)
a - K 30 607, quartzite
b - K 31 356, flint
use: scraping a medium-hard material



Mauran
(photograph: CT)
M 75 EB II E10 88, schist
use: scraping a medium-hard material

Payre
(photographs: AC)
PAY 98 N8 G3 426, flint
use: scraping a medium-hard material

Figure 216 - Unmodified flakes and tools from the sites of Les Fieux, Mauran and Payre, used to scrape a medium-hard material, probably in the context of woodworking. The black rectangles indicate the locations of the photographs of the use-wear traces presented in figure 181[d] (CAD: É. Claud and M. Coutureau).

This in turn limits our ability to determine the ultimate goals of the gestures: planing / sharpening, regularisation, re-shaping, etc. Given how narrow the active zones are, though, the fabrication of spear shafts or of projectile points in wood seems plausible for these sites where the acquisition of animal carcasses is evidenced. At Fonseigner and Chez-Pinaud, the fabrication of hafts is also a possibility, as potential hafting traces have been observed on some of the tools from these sites (see Part II, chapters 2.4 and 4.2.E). No sign of post-holes that would indicate a structure built of branches or trunks has been identified at the study sites, but the potential fabrication of such structures or of wooden tools for hide working can be imagined at these sites, given their similarity to the sites of Chez-Pinaud, Coudoulous, Fonseigner, Les Fieux, and Mauran, where such activities have been identified (see Part II, chapter 4.3.D).

The shaping of wooden blanks, as opposed to their acquisition, absolutely requires the use of stone tools or, to a lesser extent, bone tools (see Part II, chapter 4.2 "conclusion"). As such, their poor representation, even considering that a wooden object has a substantial use-life, could be evidence of a less significant investment in the fabrication of wooden objects amongst Neanderthals, in qualitative or quantitative terms. This hypothesis must of course be further investigated by more extensive use-wear analyses, especially in the Vasconian region.

E - Hafting of stone tools: rare and indirect evidence

The identification of hafting traces in the Middle Palaeolithic indicates *a priori* the use of wooden hafts, and therefore contributes directly to our knowledge of the uses of wood by Neanderthals.

In reality, over the course of our study, very few pieces showed any indication of hafting. In strictly applying the criteria proposed by V. Rots (2002, 2004, 2005, 2010, 2015a), there was not a single case that appeared with any certainty to have been hafted (see Part II, chapter 2.4). Amongst the pieces for which hafting was nonetheless suspected, we count two convergent side scrapers from Chez-Pinaud and Fonseigner and two Mousterian points from Fonseigner, all used in the cutting of animal materials (meat and/or hide, figures 187-188).

The absence of hafting traces and the difference of frequency noted between our results and those recently reported for more northern sites (Maastricht-Belvédère, Biache-Saint-Vaast, Bettencourt-Saint-Ouen, and Sesselfelsgrotte; Rots, 2014, 2015b) could be explained by several factors, detailed in Part II, chapter 2.4: excessive caution in our interpretations, issues of preservation bias for certain assemblages, and, finally, technological differences with regard to the frequency and methods of hafting (some leaving more evidence than others).

Nonetheless, in spite of the absence of hafting traces on the archaeological flake cleavers in our study sample, it must be noted that only the use of hafted flake cleavers produced similar scarring on the active zone, of the same type and extent, as those observed on the Mousterian flake cleavers that were used to chop a medium-hard material such as wood. Thus, the characteristics observed on the active zones could be taken as a sort of indirect evidence for the hafting of flake cleavers used in direct percussion (Deschamps *et al.*, 2013; Claud *et al.*, 2015). In terms of approaches to the exploitation of wood, the Vasconian sites allow us to identify evidence of percussion, probably for acquisition, but also, indirectly, the confection of handles for the purpose of hafting flake cleavers and, perhaps, other tool-types. Complementary use-wear analyses on other tools-on-flakes would be necessary to further test this hypothesis and potentially define the specific approaches that were taken (study in progress at Gatzarria, new excavations under the direction of M. Deschamps and D. Flas).

F - Summary of the approaches identified: discussion and comparative examples

In order to establish a more holistic view of woodworking in the Middle Palaeolithic, we now address other current publications on the subject in Western European contexts (see Annex 1). The number of studies published is rather substantial, numbering more than a hundred, but the heterogeneity of formats is also considerable (dissertations and theses, site reports, synthetic or specialised articles) and the amount of detail provided is equally variable, which complicates efforts at synthesis. What is more, as our data show, the interpretations are often based solely on macro-traces and are therefore imprecise with regard to the materials that were worked. In the end, the data provided in certain publications was not incorporated in the current study, due to the uncertainty with regard to the latter. Such is the case for the use-wear analyses conducted by B. L. Hardy at La Quina (Hardy, 2004), Payre (Hardy, Moncel, 2011), and Abri du Maras (Hardy *et al.*, 2013), and by A. Pawlik at Inden-Altdorf (Germany; Pawlik, Thissen, 2017). With the exception of the site of La Quina, there is no mention of a comparison with the residues that are naturally present in the archaeological sediments, and the question of potential contamination is not addressed. In the images provided, certain residues, specifically the "twisted fibres" from the Abri de Maras, appear to rest on the surface of the tools. This suggests the possibility of more recent introduction (contamination) of certain residues, which would not be tied to use. The high number of pieces presenting residues interpreted as evidence of use or hafting (98 of 129 at Abri du Maras, 125 of 182 at Payre, 148 of 300 at La Quina) is also troubling, especially in the case of assemblages that are known for relatively poor states of preservation, having undergone chemical alteration, and containing pieces that are likely to have been manipulated during earlier studies, as at Payre (Moncel *et al.*, 2009). The interpretations proposed in these studies seem to be based on isolated residues, whereas more recent residue analyses rest, for the sake of reliability, on a quantitative approach to residues that accounts for their distribution on each piece, sometimes in terms of statistical analysis (Langejans, 2011; Langejans, Lombard 2014). This critical approach has also facilitated a re-assessment of the results of the first residue analyses on the lithic assemblage of Sterkfontein (Loy, 1998), which was based on isolated residues and did not account for the taphonomic history of the samples or for recent contamination (Langejans, 2012). The author of the latter critical analysis demonstrated that the isolated residues were either of natural (sedimentary) or recent (post-excavation) origin, including the plant fibres and the fatty residues. With regard to the use-wear traces documented in these articles, the description of the latter and their photographic illustration is not convincing, and in fact suggests a natural origin. Such is the case for the numerous use-wear traces documented by A. Pawlik at Inden-Altdorf (particularly figures 5, 6, 7, 13, 16, 24, 64, 65, 71, 74, 77, 93, Pawlik, Thissen, 2017) and the so-called "impact" fractures from Abri du Maras: one of the fractures, interpreted as a burin fracture, not only displays a recent patination, but also presents no characteristic feature of a burin fracture in the photograph (Hardy *et al.*, 2013: 32, fig. 14D).

The results reported by J. Gysels and D. Cahen (1981) were re-examined by F. Collin (1985-1986), who observed in the same sample only traces of alteration, are also excluded here. Finally, results from the studies published in the 1980s must be considered with caution (see Part II, chapter 4.1, Anderson-Gerfaud, 1981; Beyries 1987a, 1988b; Beyries, Boëda, 1983) in part due to the risk of equifinality in polish from woodworking and natural (post-depositional) polish, and in part due to bias in the frequency of the different activities identified. The results of the studies of the following assemblages should be interpreted with caution: Corbiac, Pech de l'Azé I and IV, Combe-Grenal layers 22, 25, 27 and 3/F13, Biache-Saint-Vaast, Corbehem, Vaufrey, Pié-Lombard,

Marillac / Les Pradelles[3] and Grotte du Renne. For the last five of this list, studied by S. Beyries, gestures were rarely interpreted, which limits the comparative utility of these data.

If one considers the whole of relevant analyses, woodworking has been identified at widely variable frequencies, ranging from total absence (Les Tares, Abric Romaní, Bout des Vergnes, Chez-Pinaud US 22) to very high proportions (Pech de l'Azé I, IV, Corbiac, Les Pradelles, Combe-Grenal layer 3/F13, Vaufrey, Riencourt-lès-Bapaume, Rémicourt, San Quirce).

Abric Romaní yielded numerous and diverse impressions of wooden objects (Carbonell, Castro-Curel, 1992; Castro-Curel, Carbonel, 1995), and also numerous hearths containing charcoal as well as rare objects in wood made by Neanderthals. The acquisition of firewood could have been accomplished by simple collection on the landscape, as the anthracological analyses show that the wood that was burnt as fuel was dead or even dry (Allué, García-Antón, 2004; Allué *et al.*, 2017; Solé, 2007; Solé Raventós *et al.*, 2013). The worked wooden objects are essentially sharpened branches, of which impressions were found in the travertine deposits; in addition to these, there is a tripod, wooden plates, and an object in the shape of a small shovel with a handle and a flat, triangular distal end. The analyses, which are ongoing, have identified traces of scraping, sawing, and percussion on the wood artefacts. However, surprisingly, the use-wear studies conducted so far on the lithic industries of Abric Romaní (Martínez-Molina, 2005, 2008; Gauvrit Roux, 2013; Martín-Viveros Días Meco, 2016) indicate that the majority of traces identified on 448 flint tools from various levels are almost exclusively related to activities of butchery, and, to a lesser extent, hide-processing. Tools used to work wood are rare; only a single backed flake in flint (level Jb) bears polish that indicated longitudinal action on wood (Martínez-Molina, 2005: 332; Vaquero *et al.*, 2012). Two denticulates show ambiguous traces that suggest that they could have been used to scrape wood. According to the experiments conducted by K. Martínez, this absence cannot, *a priori*, be explained by taphonomy, as the fragility of the micro-polish depends on the type of flint use, and not on the material worked. This under-representation of use-wear evidence for woodworking could be explained by the use of limestone tools, rather than flint tools, which are present at Abric Romaní but have yet to be subjected to use-wear analysis (Martínez-Molina, 2005; Gauvrit Roux, 2013).

Our results, in light of those from other sites, indicate that there were two distinct stages in the exploitation of wood in the Middle Palaeolithic: acquisition and shaping. Of these two phases, only shaping necessarily requires the use of stone tools.

We will now present an overview of our data on woodworking, informed by the results of previously published studies that have provided relevant information.

Acquisition or **segmenting** belongs to the category of "primary" activities at the beginning of the *chaîne opératoire* of exploiting wood, with the aim of obtaining a blank to be consumed, transformed, or used as-is. This step was performed by **percussion** with the aid of massive tools with a cutting-edge: the flake cleavers in ophite and quartzite from the sites of Abri Olha I, El Castillo, and Gatzarria, and the bifaces from the site of La Graulet. Unmodified and retouched tools bearing traces of percussion on wood or a similar medium-hard material and that could at least in part be related to the stage of acquisition or segmenting are rare in the published studies. We can nonetheless cite two assemblages in Northern Europe that were studied by V. Rots: Sesselfelsgrotte and Biache-Saint-Vaast. At Sesselfelsgrotte, she presented evidence for the use of seven bifacial tools (mainly *Halbkeil*), hafted with wooden handles and used as axes or adzes used for percussive action on wood (distal edge; Rots, 2009). At Biache-Saint-Vaast, four pieces were used as adzes for the

3. The fauna from Les Pradelles was analysed as part of the PCR; Marillac, which was the subject of use-wear analysis conducted by S. Beyries (1987a), is the same site.

exploitation of wood: a flake with bifacial retouch on its distal end, a Levallois flake, a *déjeté* side scraper and a double side scraper (Rots, 2013). According to the author, Mousterian points and symmetrical convergent side scrapers were used primarily in hunting and butchery, as no such tools presented any clear evidence of woodworking or of percussive action. This directly contradicts the results of S. Beyries (1987a, 1988b), who identified at Biache-Saint-Vaast several hafted convergent tools used for woodworking, some of which showed evidence of percussion.

In the southwest of France, J. Rios noted three pieces at Cantalouette II (Dordogne) bearing traces of percussion against a medium-hard material, though the nature of the work and the exact material are not mentioned (Bourguignon *et al.*, 2008). Traces of percussion on a medium-hard material like wood have also been noted on Levallois flakes from locus 1 of the site of La Mouline in Dordogne, of which at least one had a convex distal working edge (Pasquini, 2008). However, the traces, of which a photograph is provided, suggest that a task of butchery involving contact with medium-hard to hard materials like cartilage and/or occasional contact with bone cannot be excluded (butchery by percussion). What is more, in this assemblage, which was subjected to a holistic use-wear study, butchery activities dominate and there is no other tool linked to other modes of woodworking.

At the surface-scatter site of Badaran in Spain, attributed to the Middle Palaeolithic, three flake cleavers in quartzite that could have been used in percussion bear micro-polish indicative of woodworking (Utrilla and Mazo, 1996). At Amalda, J. Rios-Garaizar (2010) described several pieces classified as flake cleavers in ophite and lydite that bear scarring indicative of use in percussion, but the material worked was not identified. Thus, the tools that were used in percussive action on wood in the stage of acquisition or segmenting that are documented in the existing literature share certain features with those identified in our study (figure 239, table 71): bifacial pieces with transverse distal cutting-edges (Sesselfelsgrotte and to a lesser extent Biache-Saint-Vaast), flake cleavers (Badaran) and diverse macro-tools (Amalda).

This stage of acquisition and segmenting could also have been achieved with the longitudinal action of **sawing**, which does not require large flakes or hafting. Rather than requiring brute force, this approach takes a considerable amount of time. This approach could be more widespread than the percussive approach, as traces of longitudinal action on wood, or a medium-hard material, were identified at Chez-Pinaud, Mauran, Fonseigner, Payre, Coudoulous and Les Fieux. No tools used in the percussion of medium-hard materials were identified at these sites, with the exception of Chez-Pinaud, where a side scraper was used in this manner. This rather light tool would be better suited to stripping branches or shaping wood than for the segmenting of a trunk (see Part II, chapter 4.2.B). This observation could indicate differences in behaviour, in terms of approaches to woodworking, in the difficulty of acquisition (quality, properties, and dimensions of the wood available) and in the objectives of woodworking at these sites, in comparison to those at which percussive action was employed (see above). But this hypothesis is complicated by issues of equifinality, as evidence for longitudinal action could also be linked to a stage of shaping (grooving, incision).

In the literature, the tools identified as having been used in longitudinal action compatible with sawing wood are generally few in the assemblages that include them, but such assemblages are themselves not rare (table 59).

At Sesselfelsgrotte and Biache-Saint-Vaast, sawing of a medium-hard material or of wood was not clearly identified, though traces compatible with such activities were found on pieces from Cantalouette II and Amalda. This could indicate the use of two different modes of acquisition at the same site, but could also result from the use of percussive action in the phase of acquisition and longitudinal action in the phase of shaping. At the first two sites, we cannot exclude that another complementary approach to acquisition was documented by V. Rots (2009, 2013), who identified tools that were used as knives, in longitudinal action, on an unknown material.

The state of the wood worked by sawing is rarely determined or mentioned. As an exception, at San Quirce, the wood was determined to have been green on the basis of numerous micro-polish characteristics.

In our study assemblages, three principal types of tools were used in longitudinal action: unmodified flakes (15), backed knives (2), denticulates (4), and to a lesser extent side scrapers (1). These tools, in flint and in quartzite, display diverse morphological characteristics, in terms of blank morphology (dimensions, elongation, ...) and active zones (outline, angle). The notched pieces, points, and bifaces in the assemblages did not bear traces compatible with sawing wood.

The types of blanks described in the literature are equally diverse (table 59) but correspond more or less to the types we describe here (figure 239, table 70), with the exception of bifacial pieces. We must express here our reserves when it comes to the published interpretations of the bifaces at Grotte XVI (Soressi, Hays, 2003) and the bifacial side scraper at Saint-Brice-sous-Rânes (Cliquet, 2001). The micro-photographs provided are not convincing (perhaps due to their poor quality) and lead one to suspect a natural origin for the states of the surfaces and edges depicted.

	Site	Wood scraping traces	Traces due to longitudinal motions on a medium hard material like wood	Related tool types
North France	Bettencourt-Saint-Ouen	x		double scraper and Levallois point
	Corbehem	x		core edge flakes (from Levallois debitage)
	Saint-Brice-sous-Rânes	x		double scraper with bifacial retouches
South-West France	Cantalouette II		x	undetermined
	Combe-Grenal (layers 21-25)	x		Quina scrapers
	Corbiac	x		denticulate and endscraper
	Grotte XVI	x		bifaces
	Abri du Musée		x	undetermined
	Pech de l'Azé I	x		denticulates
	Pech de l'Azé IV	x		denticulates
South-East France	Champ-Grand	x		scraper resharpening flake
	La Combette (levels A, B1, D)	x		undetermined
Italy	Grotta Breuil (layers 3, 6, XX)	x		undetermined
	Ciota Ciara cave		x	denticulate and unretouched flakes
	Santa Croce		x	undetermined
Iberian Peninsula	Abric Romaní (levels H, I, Ja)	x		core edge flake
	Amalda	x		elongate flakes (from Levallois debitage), scraper and small flake (all in flint)
	Bajondillo cave	x		denticulate, scraper, unretouched flakes
	Cueva Morín (layer 16)	x		retouched flake, mousterian point and scraper in flint; denticulate and unretouched flakes (from Levallois, Kombewa, unipolar debitage) in quartzite
	Ribeira Ponte da Pedra / Atalaia		x	unretouched flakes
	San Quirce	x		unretouched blades and elongated flakes

Table 59 - Published data on Middle Palaeolithic assemblages in Western Europe that have yielded traces related to longitudinal actions on wood or on a semi-hard material like wood, and the types of pieces presenting these traces. See Annex 1 for the literature references.

The distribution of trace evidence is also dubious on the bifaces from Grotte XVI, with the micro-traces sometimes located on the interior of the pieces and not just the edges, and only on one face. This distribution does not conform to use-wear traces and suggests, at least for certain bifaces, a natural origin. We must note here the absence of Clactonian notched pieces used in this action. Also, though unmodified edges and denticulates seem, in our study, to be the most commonly used for longitudinal action on medium-hard materials, other tools, such as side scrapers, were also employed to this end to a lesser extent. The relative diversity of the pieces used in longitudinal action could reflect a certain diversity of activities, and it is tempting to relegate the quartzite pieces and the pieces with retouched edges to the acquisition of green wood (the irregular edges being better suited to penetrating the material), while the unmodified flint flakes would have served well in incision or grooving. Ultimately, though, the current results of the various analyses are not sufficient to support interpretations at this level of detail.

The second stage we have defined is that of **shaping** or **maintenance** of structures or objects in wood. Theoretically, this stage encompasses a wide range of objectives: bark-stripping, roughing-out, finishing, decoration, perforation, splitting, or maintenance of wooden objects. Because plant materials were not preserved at our study sites, the different types of objects that were manufactured can only be inferred from the other activities (hide-processing, hunting) documented at the sites (see Part II, chapter 1.2). Based on these, we can imagine that woodworking was related to the manufacture of diverse hafting mechanisms (curved or straight morphology; male, split, or juxtaposed arrangement), hunting equipment (spears, hafts, and points), and containers, but also structures for shelter, for stretching hides (frames, stakes), drying meat, and perhaps also for hide working (*lissoirs*).

In our study assemblages, shaping is primarily evidenced by tools that show traces of **scraping**. With the exception of Saint-Césaire and Grotte du Noisetier, all of the assemblages subjected to holistic analysis yielded tools that were used in scraping medium-hard materials like wood. In the literature, transverse actions are the most frequently identified in woodworking. They are present at numerous sites (table 60), and especially abundant at: Sesselfelsgrotte, Corbehem, Riencourt-Lès-Bapaume, La Folie, Pech de l'Azé I and IV, Corbiac, Grotte XVI, La Combette (level D), San Quirce, Bajondillo, and Grotta Breuil (layer 3). They were also identified, in smaller numbers, at: Biache-Saint-Vaast, Bettencourt-Saint-Ouen, Maastricht-Belvédère (site J), Rémicourt, Spy, Le Pucheuil, Cantalouette II, and Champ-Grand. They are potentially present at other sites where tools presenting traces of scraping on unidentified medium-hard materials have been identified: Neumark-Nord, Saint-Amand-les-Eaux, Beauvais, Havrincourt, Le Fond des Blanchards, Amalda, Abri du Musée, Latrote, Chemin de Jupiter, Baume Vallée, Fumane, Ciota Ciara and Santa Croce.

The scarcity or even absence of micro-polish within our study assemblages did not allow us to determine with precision the exact gesture (working angle, for example), the state (dry versus fresh) of the wood, or the objective of woodworking. In the available publications, the state of the wood is rarely mentioned. Nonetheless, the working of dry wood and green wood has been noted at Grotta Breuil and at La Combette; green and dry wood would have been worked at Riencourt-lès-Bapaume and only green wood at San Quirce. Information concerning the exact activities (thinning, scraping, planing, polishing) (see table 60) and the use-wear evidence on which the interpretations rest are not always available (notably at La Combette, Grotta Breuil, Combe-Grenal – layers 21 to 24 –, and San Quirce).

In our study set, various types of blanks were used in transverse action on wood or a medium-hard material like wood: unmodified flakes, pseudo-Levallois points, backed knives, denticulates, side scrapers, and notched pieces in flint and quartzite. The characteristics of the active zones are variable and the cutting edges present more or less open angles. The active zones are often short, which may indicate the working of slender objects such as shafts, points, or spears.

This diversity of stone tools can also be found in the literature (table 60), though in some cases, at the scale of a single assemblage, trends are observed that support the attribution of a specific category or morphology of tool to this mode of use (Sesselfelsgrotte and San Quirce, see table 60). Thus, the pieces bearing evidence of transverse action on wood or a medium-hard material like wood are very diverse: unmodified flakes produced by different methods of debitage (Quina, Discoid, Levallois, Le Pucheuil), Mousterian points, Levallois points, pseudo-Levallois points, side scrapers, denticulates, notched pieces, endscrapers, and even bifaces. However, with regard to bifaces, the studies are in large part older (Anderson-Gerfaud, 1981), and in more recent studies (Rémicourt, Grotte XVI), the micro-photos provided and the distribution of traces point to a taphonomic origin.

	Site	Wood scraping traces	Traces due to scrapping medium hard material like wood	Related type tools
Belgium	Rémicourt	x		biface, denticulate, unretouched flakes, retouched flakes
	Spy	x		Mousterian points
Netherlands	Maastricht-Belvédère (site J)	x		unretouched flakes
Germany	Neumark-Nord		x	undetermined
	Sesselfelsgrotte	xx		points, scrapers and bifacial tools (with a triangular morphology, hafted in a distal position in split wooden handle with bindings)
North France	Beauvais "La Justice"		x	pseudo-Levallois points
	Bettencourt-Saint-Ouen	x		short and thick pieces often retouched (scrapers, endscrapers, backed knives)
	Biache-Saint-Vaast	xx		convergent and et non convergent scrapers
		x		Levallois flakes and scrapers (hafted)
	Corbehem	xx		core edge flakes (from Levallois debitage)
	Havrincourt "Les Bosquets"		x	unmodified and retouched flakes
	Le Pucheuil	x		"Le Pucheuil" flakes
	Riencourt-lès-Bapaume	xx		scrapers with convex edge
	Saint-Amand-les-Eaux		x	small and elongated backed flake
North-Central France	La Folie	xx		elongated flakes
	Le Fond des Blanchards		x	trapezoidal scrapers
South-Western France	Bayonne Jupiter (PM2)		x	scraper with convex edge
	Cantalouette II	x	x	undetermined
	Combe-Grenal (layers 22, 25, 27)	x		scrapers
	Combe-Grenal (layers 21-24)	x		Quina scrapers
	Corbiac	xx		endscrapers, scrapers (with straight, convex or concave and convergent edges), denticulate and biface in flint
	Grotte XVI	xx		bifaces
	Abri du Musée		x	undetermined
			x	backed scraper (traces on the back)
	Latrote		x	scraper
	Pech de l'Azé I	xx		scrapers (with straight, convex or concave edge), denticulates, endscrapers, bifaces
	Pech de l'Azé IV	xx		scrapers (with straight and convex edge), denticulates, endscrapers

	Site	Wood scraping traces	Traces due to scrapping medium hard material like wood	Related type tools
South-Eastern France	Baume Vallée		x	retouched edges (scraping) / unretouched edges (planing)
	Champ-Grand	x		*limace* and scraper in flint
		x		scraper in rock crystal
	La Combette (levels A and B)	x		scrapers
	La Combette (level D)	xx		unmodified flakes and scrapers (with a straight profile)
Italy	Grotta Breuil (layer 3)	xx		unmodified flakes and scrapers (with biplanar section, straight profile, straight and concave delineation of the active zones)
	Grotta Breuil (layer 6)	x		flakes (with concave delineation, biplanar section, and straight to convex profile of the active zones)
	Grotta Breuil (layer XX)	x		unmodified flakes and scrapers (with various section, straight or concave profile and convex delineation of the active zones, average cutting angle of 74°)
	Fumane (BR4 and 5)	x	x	Quina scrapers
	Fumane Discoïde		xx	unmodified flakes
	Ciota Ciara cave		x	Mousterian point and unmodified flakes
	Santa Croce		x	laminar flakes
Iberian Peninsula	Amalda		x	endscraper-core, denticulate, flakes and scrapers
	Axlor	x		points
		x		retouched flakes from the resharpening of scrapers, scrapers
	Bajondillo cave	xx		scrapers, notches, denticulates, burins
	Cova Eiros	x		Quina scraper
	Cueva Morín (layer 16)	x		scraper, retouched flakes from the resharpening of scrapers
	Cueva Morín (layer 18)	x		retouched flakes from the resharpening of scrapers
	Ribeira Ponte da Pedra / Atalaia	x	x	unmodified flakes
	San Quirce	xx		flakes and choppers (cutting edge angle of 35° for scraping and 70° for polishing and planning)

Table 60 - Published data on assemblages from the Middle Palaeolithic of Western Europe that have yielded traces related to transverse actions on wood or on a semi-hard material like wood, and the types of pieces presenting these traces. See Annex 1 for the literature references.

In our study assemblages, **perforation** has not been identified with any certainty (due to the absence of micro-polish and the problem of equifinality with regard to dry hide and wood in this mode of action) but it is suspected in the case of three pieces from Les Fieux (an unmodified flake and a pseudo-Levallois point in flint, and a denticulate in quartzite), two pieces from Mauran (a Clactonian notch and a denticulate in flint), and twelve pieces from Payre (flint flakes, table 49, figure 214). This mode of action is also rarely mentioned in the literature. It is identified on a Mousterian point at Spy and a Mousterian point at Riencourt-lès-Bapaume (three other points were potentially used in this manner, amongst them a Levallois point; Beyries, 1993). Several pieces in flint might have served as perforators, at Sesselfelsgrotte and at Biache-Saint-Vaast. Three pseudo-Levallois points from Beauvais, two pieces from Rémicourt and a side scraper from Latrote bear traces suggesting perforation of a medium-hard material, and a denticulate with macro-denticulation from Romentères presents scarring compatible with this mode of use.

Like perforation, **grooving** has not been identified in our assemblages and is rarely mentioned in the literature; the sites of Rémicourt (sector A), Grotta Breuil (layer 3) and Santa Croce provide the only examples.

The same is true for the use of **intermediate pieces** in the transformation of wood by indirect percussion, as a wedge for splitting, or as a gouge or chisel for shaping. In our study series, it has not been identified with certainty, though two pieces were noted as possible intermediate pieces in the assemblage from Chez-Pinaud (a flint side scraper and an unmodified flake, both fractured). The fractured edge bears damage indicative of percussion by direct contact with a stone hammer. Scarring is present at the opposite end of the side scraper, but no micro-polish could be identified. This mode of action is rarely mentioned in the Middle Palaeolithic of Europe and only a few assemblages include pieces that potentially indicate it: Biache-Saint-Vaast (a retouched flake in flint), Rémicourt (robust and retouched flakes), and, to a lesser degree Amalda (a sandstone "flake cleaver") and Cova Eiros (quartz pieces), as the material worked could not be determined.

Several modes of action, frequently observed in the Upper Palaeolithic for the transformation of hard animal materials (see for example de Araújo Igreja, 2003; Tartar, 2009) and which one could expect to see in the case of Middle Palaeolithic woodworking, such as perforation, grooving, and indirect percussion, have thus proven to be quite rare, whether in the case of previously published studies or the new results from the PCR studies. Though grooving may have been underestimated due to the absence of preserved micro-polish – the higher (less acute) edge angles generally used in grooving tend to bear little scarring – such is not the case for perforation and indirect percussion, which leave macro-traces that are usually pronounced and characteristic. This is especially the case for intermediate pieces struck with a hammer in a hard mineral material, which develop clearly diagnostic marks: large and superimposed scars, cracks and pullout or crushing from impact (Claud, 2008). The use of a hafted intermediate piece would not leave traces of contact with the hammer, but one could expect to find pronounced traces of hafting, which is not noted in our series, in which potentially hafted tools were used in cutting and not percussion. Finally, the use of an organic hammer rather than a mineral one would leave much less pronounced traces and cannot be excluded.

The synthesis of our results on woodworking, integrating the data already available for the Middle Palaeolithic of Europe, presents the opportunity, at last, to define the different types of actions performed on wood without great precision regarding the intentions and the different modalities enacted by Neanderthals. Nonetheless we will suggest here some elements of interest for future studies and discussions:

- on the presence and importance of woodworking:
- rare direct evidence for the use and transformation of wood exists in the form of wooden objects recovered from two sites (Abric Romaní, Lehringen). Some of them bear traces of scraping, sawing, and percussion;
- with the exception of two assemblages (Rémicourt, San Quirce), and in contrast to proposals made in the 1980s, woodworking is weakly represented in comparison with butchery activities. The scarcity of tools devoted to woodworking is not a product of preservation bias, but reflects, in our view, a prehistoric reality;
- objects in wood, whose production generally requires a considerable time investment, would have been kept over long periods of time and transported regularly, which could explain why tools related to their production are both rarely identified in general and rarely associated with wooden objects found *in situ* (at Abric Romaní for example);
- the tools used in woodworking could have gone unidentified in archaeological assemblages, either because they were made in materials that were not yet subjected to functional analyses

(like the limestone tools at Abric Romaní), or because they are often lithic objects with little to no modification, as evidenced in certain ethnohistorical examples (Hayden, 2015, fig. 8);
- there does not seem to be a clear relationship between environment and Neanderthal investment in the processing of woody materials, as some occupation sites that were evidently in forested and temperate environments (see table 46, Part II, chapter 1) have yielded little or no tools dedicated to woodworking, while, *a contrario*, certain assemblages in more hard climates and open landscapes bear strong proportions of tools used to work wood. Neanderthal responses to factors other than environment must have influenced investment in the use of wood materials: specific needs related to site function, technological traditions, modalities of processing or conserving animal resources (smoking, drying, freezing).

• on the modes of acquisition and processing of wood evidenced:
- it is possible that the acquisition of wood was accomplished by percussion or by sawing;
- the shaping of objects was primarily by scraping; other modes of action were rare: perforation, grooving, use of an intermediate piece. The evidence indicates a rather restricted range of activities to the use of wood;
- the tools that served in scraping are generally highly variable, as are those used in longitudinal action. This diversity of tool forms may reflect distinct activities that we are not able to identify or choices that were made based on opportunity, skills, and technological traditions within human groups. At the scale of an assemblage, it is sometimes possible – when the tools used in woodworking are well represented – to identify trends in the morphology of tools used in scraping wood, or even several groups of tools. This is the case, for example, at Sesslfelsgrotte, where, according to the typology of the pieces, traces related to scraping wood were only found on pieces with a triangular morphology and, additionally, bear evidence of hafting. At San Quirce, two groups of tools were identified: those with edge-angles of 35° for scraping and those with edge-angles of 70° for polishing or planing;
- there seems to be a relationship between tools with a transverse cutting edge, whether flake cleavers, bifaces, or bifacial pieces, and the use of percussion on wood-like materials, probably in the phase of acquisition. These pieces suggest that the intended objectives required the production of massive tools.

It is only through a systematic approach to the analysis (see Introduction) of older assemblages and more recent ones that we will be able to augment the available data on woodworking and deepen our understanding of the importance of wood and modes of its exploitation in the Middle Palaeolithic. A holistic use-wear study of Vasconian assemblages that are adequately preserved could allow us, for example, to obtain new information on the tools that were used in the transformation of wood, but also in the acquisition of fibrous materials, in addition to the flake cleavers used strictly for such purposes. Additionally, the re-analysis of assemblages that were previously studied and reported to evidence a significant amount of woodworking by distinct methods (perforation, scraping, and, notably, indirect percussion) presented an opportunity to confirm or reject these initial interpretations and to obtain additional information by enlarging the study samples at each site (Riencourt-lès-Bapaume, Rémicourt, and to a lesser extent Bettencourt-Saint-Ouen, Corbehem, Corbiac, Combe-Grenal, Les Pradelles, Pech de l'Azé I and IV).

Finally, in order to understand woodworking as a whole, and not just in reference to the lithic tools used in it, it is necessary to research potential applications of tools in osseous materials that could have been used in the stages of debitage or shaping of wood, especially by splitting-and-wedging, which has been demonstrated for the Aurignacian (Tartar, 2009). With the exception of retouchers, bone tools are rarely identified in Mousterian sites. Pieces of bone with scarring may

indicate their use as intermediate pieces used in the indirect percussion of wood. Pieces with evidence of percussion on only one end may have been used in direct percussion. Known at some rare sites like Combe-Grenal, La Ferrassie, Axlor (Mozota Holgueras, 2012; Tartar, Costamagno, 2016) and Grotte du Noisettier (Oulad el Kaïd, 2016), their rarity in Mousterian contexts is probably due more to the ambiguous nature of their diagnostic features than any true scarcity (Tartar, Costamagno, 2016). Finally, the presence of a bone scraper with use-wear traces indicating wood scraping has been reported at Fumane (A5-A6, Romandini *et al*., 2015).

3 - Approaches to the acquisition and use of animal materials

(S. Costamagno, É. Claud, M.-C. Soulier, C. Thiébaut, M. Brenet, A. Coudenneau, M. Deschamps, C. Lemorini, V. Mourre, F. Venditti)

A - Approaches to hunting employed by Neanderthals in Western Europe

Bison, red deer, horse, ibex, chamois and other large and small ungulates are the classic prey animals exploited by Neanderthals. The study of several sites has shown that Neanderthal hunting was not always restricted to this category of animals. Very large ungulates were also sometimes exploited. Cutmarks have been found on megaloceros bones in assemblages XII and XVIIc at Bolomor in Spain (Blasco, Fernández Peris, 2012) and a piece from Moula demonstrates the use of the bones of this animal for utilitarian purposes (Valensi *et al.*, 2012). Several sites, located primarily but not exclusively in northern Europe, – have yielded megafaunal remains in abundance (mammoth, rhinoceros, straight-tusked elephant: for example La Cotte de Saint Brelade, Biache-Saint-Vaast, Mesvin IV, Spy, Tata, Ranville, Gröbern, and Lehringen); butchery marks have been identified on some remains at La Cotte de Saint Brelade, Biache-Saint-Vaast and Payre (Auguste, 1995; Daujeard, 2008; Smith, 2015), at Taubach (Bratlund, 1999), and at Bolomor and Preresa (Blasco, Fernández Peris, 2012; Yravedra *et al.*, 2012). In Germany, the exploitation of elephants is demonstrated by 28 lithic artefacts found in association with a carcass at Gröbern and a spear discovered between the ribs of a carcass at Lehringen (Weber, 2001). At Asolo in Italy, a mammoth was recovered in association with Mousterian tools (Mussi, Villa, 2008).

Although carnivores are present in Middle Palaeolithic faunal assemblages, evidence that they were exploited by Neanderthals is rare. There is evidence for the exploitation of wolf at Portel, La Cotte de Saint Brelade, Fumane, and Ciota Ciara (Gardeisen, 1999; Romandini *et al.*, 2014a; Smith, 2015; Buccheri *et al.*, 2016); fox at Chez-Pinaud, Bolomor, and Fumane (Jaubert *et al.*, 2008; Blasco, Fernández Peris, 2012; Romandini *et al.*, 2014a), lynx at Lazaret and at Bolomor (Valensi, Psathi, 2004; Blasco, Fernández Peris, 2012), cave lion at Grotta delle Fate and Bolomor (Valensi, Psathi, 2004; Blasco, Fernández Peris, 2012), and wildcat at Abric Romaní (Gabucio *et al.*, 2014b). Indications of the exploitation of bears are more common, including cave bear (Arcy-sur-Cure, Le Portel, La Cotte de Saint Brelade, Scladina, Taubach, Bocktein, Hohle Fels, Madonna dell'Arma, Ciota Ciara, Badalucco, Fumane: Gardeisen, 1994; David, 2002; Bratlund, 1999; Quilès, 2004; Münzel, Conard, 2004; Cauche, 2007; Kitagawa *et al.*, 2012; Abrams *et al.*, 2014; Smith, 2015; Buccheri *et al.*, 2016), brown bears (Regourdou, Biache-Saint-Vaast, Grotte delle Fate, Grotte de Manie, Fumane, Moscerini, Sant Agostino: Stiner, 1994; Auguste, 1995; Quilès, 2004; Valensi, Psathi, 2004; Cavanhié, 2011; Jéquier *et al.*, 2012; Romandini *et al.*, 2014), and, rarely, polar bear (Taubach: Bratlund, 1999) or Tibetan bear (Grotte de Cèdres: Bez, 1995) (see Armand, 2018, for a synthesis of this topic). Regarding small animals, there is evidence for the exploitation of leporids (Les Canalettes, Le Lazaret, Combe-Grenal, La Crouzade, Pié Lombard, Orgnac, Salpêtre de Pompignan, Gorham Cave, Cova Negra, Bolomor, Cova Beneito: Gerber, 1972; Chase, 1986; Guennouni, 2001; de Lumley *et al.*, 2004; Sanchis Serra, Fernández Péris, 2008; Cochard *et al.*, 2012; Morin, 2012), beaver at Taubach and Grotte Maggiore di

San Bernardino (Bratlund, 1999; Fiore *et al.*, 2004) and marmot at Kogelstein (Münzel, Conard, 2004). Birds were also exploited by Neanderthals, as illustrated by cutmarks observed on remains of falcon, vulture, golden eagle, crow, pigeon, and/or swan at Mandrin, Lazaret, Les Fieux, Grotte de la Hyène at Arcy-sur-Cure, Baume de Gigny, Combe-Grenal, Pech de l'Azé IV and I, and at Grotte du Noisetier in France (Mourer-Chauviré, 1975, 1989; Roger, 2004; Soressi *et al.*, 2008; Dibble *et al.*, 2009; Morin, Laroulandie, 2012; Gerbe *et al.*, 2014; Romandini *et al.*, 2014b), at Bolomor, Vanguard, and Ibex Cave in Spain (Sanchis Serra, Fernández Peris, 2008; Blasco, Fernández Peris, 2009, 2012; Blasco *et al.*, 2010; Finlayson *et al.*, 2012) at Rio Secco Cave and Fumane in Italy (Fiore *et al.*, 2004; Romandini *et al.*, 2014b; Peresani *et al.*, 2011a) and at Salzgitter-Lebenstedt in Germany (Gaudzinski, Niven, 2009). Tortoises are also included in the spectrum of fauna exploited by Neanderthals, for instance in assemblage IV at Bolomor and levels 19 to 15 at Gruta da Oliveira, which yielded a large number of remains, many of which present cutmarks, signs of fracture, and traces of burning and of consumption (Blasco, 2008; Nabais, 2011). With regard to aquatic fauna, indications of exploitation are markedly more rare and difficult to identify. The bones recovered at Grotte Vaufrey could indicate the exploitation of fish (Le Gall, 1989); Vanguard provides evidence for the exploitation of pinnipeds (Stringer *et al.*, 2008) and numerous mollusc shells have be found at the sites of Vanguard, Gorham cave, Bajondillo, Cueva de los Aviones, Antón, and El Cuco in Spain, at Figueria Brava in Portugal (Callapes, 2000; Zilhão *et al.*, 2010; Cortés Sánchez *et al.*, 2011a; Fa *et al.*, 2016; Gutiérrez-Zugasti *et al.*, 2017) and at Grotta Breuil and Moscerini in Italy (Stiner, 1994; Stiner *et al.*, 2000). For molluscs, there is evidence of selection amongst the shells, as well as traces of burning and intentional perforation that indicate that these resources were consumed by Neanderthals (Zilhão *et al.*, 2010). Terrestrial snails were also consumed at La Cueva 120 (Agusti *et al.*, 1992; Terradas, Rueda, 1998).

Most authors today agree that ungulates classically present in Middle Palaeolithic faunal assemblages (red deer, reindeer, horse, bison, ...) were acquired by hunting, with the possibility of occasional scavenging of carcasses when conditions permitted. With regard to hunting strategies and techniques, we can refer to those documented at sites dedicated to hunting and butchering of large bovids. At Mauran, La Borde, Les Fieux and Coudoulous in southwestern France, specific topographic features of the landscape (pit caves, bases of cliffs) were repeatedly exploited as natural traps for the acquisition of large numbers of bovids. This strategy was also originally proposed to explain the presence of mammoths at La Cotte de Saint Brelade (driving the herds toward the ravine: Scott 1980, 1986), but more recent studies have shown that, during periods of low sea level, a valley terminated at the entry of the site. A hypothesis of driving toward the end of this valley is preferred today (Scott *et al.*, 2014). At Salzgitter-Lebenstedt in Germany, the narrowing of the valley could have been used advantageously for intercepting reindeer (a minimum of 86 individuals has been determined) during their autumnal migration (Gaudzinski, Roebroeks, 2000). Acquisition of prey by driving parts of herds toward a natural trap is thus one hunting technique employed by Neanderthals (Farizy *et al.*, 1994; Gaudzinki, Roebroeks, 2000; Coumont, 2006; Rendu, 2007; Gerbe *et al.*, 2014; Jaubert *et al.*, in prep.). Although this technique requires close coordination amongst group members, it presents a double advantage: it avoids direct contact with potentially dangerous animals and it does not require throwing or thrusting weapons as the animals can be killed in the fall. At Les Fieux and Mauran, not a single point was clearly identified as a hunting weapon. Only two pieces bear fractures that could have been produced by impact. The scarcity or even absence of lithic hunting points at these sites suggests that the bison hunters of Mauran and Les Fieux would have, if necessary, finished off certain prey animals with heavy stone blocks or with wooden spears like those found at Lehringen and Schöningen (Germany), at Clacton-on-Sea (England), and at Ljubljansko Barje (Slovenia) (Movius, 1950; Oakley *et al.*, 1977; Dennel, 1997; Thieme, 1997; Gaspari *et al.*, 2011). In this context, the site of Coudoulous could be an exception with the

presence of two triangular elements in quartzite that were most certainly used as hunting weapons. The hunters at Coudoulous could have used at least two different techniques: driving part of the herd into a pit-cave and using stone weapons to hunt other types of prey, or as a means of defence in case of contact with bison.

The faunal assemblages from some sites contain only certain parts of animal carcasses (generally the meatiest parts) that were processed offsite by Neanderthals. These are Grotte du Noisetier, Les Pradelles, Chez-Pinaud, Saint-Césaire, Gatzarria, and Payre in France (Morin, 2004; Costamagno *et al.*, 2006; Rendu, 2007; Ready, 2010; Niven *et al.*, 2012), as well as Grotte XVI, Pech de l'Azé, Vaufrey, Abri des Pêcheurs, Baume Flandin, Abri du Maras, Lazaret, and Wallerteim in Germany, Fumane in Italy, and Abric Romaní in Spain (Grayson, Delpech, 1994, 2003; Gaudzinski, 1995; Valensi, Psathi, 2004; Martinez *et al.*, 2005; Daujeard, 2008; Moncel *et al.*, 2010; Romandini *et al.*, 2014a). These sites have been interpreted as long-term or seasonally occupied locations, or as butchery camps for secondary processing of carcasses. At Wallerteim, more than sixty bisons and horses were acquired by hunting of small groups with the selection of adult individuals (Gaudsinski, 1995), indicating that Neanderthals did not choose their prey at random, but were capable of exercising true selectiveness of even the fittest and most dangerous animals.

With regard to the sites of Bayonne le Prissé, Saint-Césaire, Chez-Pinaud, Fonseigner, and Grotte du Noisetier, a holistic use-wear study of the lithic artefacts has been conducted. The level at Payre benefited from a focused use-wear analysis of triangular elements. Of 298 pieces studied, none presented use-wear or damage unambiguously indicative of use as a hunting weapon, with the exception of a single point from Chez-Pinaud that presented a burin fracture on the distal end and potential hafting traces (see Part II, chapter 2.4).

How should one interpret this scarcity of points used as hunting projectiles? Is it perhaps the case that the samples analysed in our study are dominated by blanks that are ill suited to the production of such points? This hypothesis seems reasonable for the assemblages in which only bifaces and flake cleavers have been studied, but also for the assemblages from Mauran, Saint-Césaire, and Les Fieux, in which debitage is oriented toward the production of backed pieces and relatively thick pseudo-Levallois points (Thiébaut, 2005) with morphologies that are incompatible with effective use as projectiles. All the same, one of the largest assemblages of points that could have served as hunting weapons comes from a level at the site of Beauvais (Coudenneau, 2013). Of the 428 points studied, 21 show traces of use in diverse activities and 10 bear removals on the distal ends comparable to those observed on points used experimentally as projectiles. They are unmodified pseudo-Levallois points, not even thinned, derived from a Discoid debitage sequence comparable to those noted at Mauran and Les Fieux. If these points really served as projectiles, they would testify to the strength of technological tradition amongst Neanderthal groups in the hunting techniques used.

At Fonseigner, in contrast, certain blanks (Mousterian points with axial symmetry) are morphologically compatible with use as hunting weapons. Some, relatively thin, blanks at Saint-Césaire or at Chez-Pinaud could also have been shaped by retouch into Mousterian points. However, in these assemblages, no definite armature point was identified. Other sites rich in points that were analysed also failed to provide any element that was definitively used as a hunting weapon. Such is the case, for example, at Terdonne and Spy, where the Levallois and Mousterian points show no clear signs of impact. At these two sites, from which a combined total of 119 unmodified Levallois points and 82 Mousterian points were analysed, only eleven pieces displayed fractures of the distal end that might have resulted, amongst other hypotheses, from use as hunting weapons (Coudenneau, 2013).

Several other European sites have yielded elements identified as points used in hunting, more or less numerous (table 61).

	Site	Impact traces	Uncertain impact traces	Related tool types
Belgium	Spy		1	Mousterian point
Netherlands	Maastricht-Belvédère (site K)	1		retouched and pointed flake
Germany	Sesselfelsgrotte	28		bifacial scraper, scrapers, points, flake and blade fragments
North France	Beauvais "La Justice"		10	pseudo-Levallois points
	Bettencourt-Saint-Ouen (N2b, a, N1)		1	Levallois point
	Bettencourt-Saint-Ouen (N2b)	6		Levallois points
	Biache-Saint-Vaast	20		convergent scrapers, points
	Therdonne		3	pseudo-Levallois points
North Center France	Angé		5	Mousterian points
South Western France	Bouheben	6		Mousterian points, convergent scrapers
	Cantalouette II	1		point
South Eastern France	Abri du Maras	5	6	Soyons points, Levallois points, blade and flake fragments
	Mandrin (layer E)	71		unmodified and retouched points (including micro and nano-points)
	Mandrin (layer D)	31		unretouched pseudo-Levallois points, truncated pseudo-Levallois points and Levallois points (classic points and unmodified and retouched micro-points)
	Mandrin (layers B and C)	11	6	unretouched points and flakes
	Mandrin (layer F)	3	1	Levallois and Mousterian points
Italy	Asolo	1		unretouched point
	Ciota Ciara cave	1		convergent scraper (in quartz)
	Oscurusciuto	6		Mousterian points
Iberian Peninsula	Abri del Pastor	8		retouched points (in flint)
	Amalda		3	Mousterian point, pointed flake, retouched Levallois point (in flint)
	Arlanpe	1		Levallois point (in flint)
	Axlor (N, M, D)	5		retouched points (in flint)
	Cova Eiros	2	3	Levallois points (in quartzite)
	Cueva Morín (layer 16)	5		Mousterian point, Levallois points and pointed flake (in flint)
	El Castillo	7		Mousterian points (in flint)
	La Verde		1	Mousterian point (in silicified sandstone)
	Lezetxiki	2		retouched points (in flint)

Table 61 - Published data on assemblages from the Middle Palaeolithic of Western Europe that have yielded armatures with impact damage (possible or definite), and the types of pieces that present such traces. See Annex 1 for the literature references.

In Germany, 28 pieces of varied type from the site of Sesselfelsgrotte could have served as hunting weapons, and their use as both thrusting and throwing arms is seen as possible (Rots, 2009). The on-going study by V. Rots (2015b) of the lithic industry at Maastricht Belvédère (site K) demonstrates the use of a single point as a hunting weapon. In the northern France, six Levallois points from the site of Bettencourt-Saint-Ouen (Somme; Caspar *in* Locht *et al.*, 2002; Rots, 2015b), and, at most, 20 pieces from Biache-Saint-Vaast (Pas-de-Calais; Rots, 2013) bear impact damage. A bit farther south, five Mousterian points from the site of Angé (Loir-et-Cher) present fractures and lateral scarring that are compatible with this mode of use (Soressi, Locht, 2010; Locht *et al.*, 2015).

In southwestern France, the assemblages that have yielded points with traces of impact or potential traces of impact are very rare: at the open-air site of Bouheben (Landes), six Mousterian points of the 100 analysed present such fractures (Villa, Lenoir, 2006). A point interpreted as a projectile by J. Rios was noted at the site of Cantalouette II (Bourguignon *et al.*, 2008).

For the southeast, if we exclude the dubious result reported by B.L. Hardy at Abri du Maras (Hardy *et al.*, 2013; Part II, chapter 4.2.F), the only available study is that of L. Metz, in her doctoral thesis (2015) on the site of Mandrin. Layer E of the site, notably, yielded a highly unique lithic assemblage (numerous points, standardized and tending toward the microlithic scale). At least 15.5 % of these points could have been used as wounding or penetrating arms, and more than a third of the small points (called micro- and nanopoints) were found to bear diagnostic impact damage. Given the small dimension of these points, their use in bow-hunting is hypothesized.

Under the new interpretive program of the Musée d'Orgnac, we (C.T., E.C.) were led to examine the points from several sites in the Rhône Valley (Abri Moula, Abri des Pêcheurs, Abri du Maras). At least four of them bear damage indicative of probable use as arms. Our observations join those of L. Metz, who identified several points with impact damage at Abri du Maras (Metz, 2015: 131-138, volume 2).

In northern Spain, the data are more abundant as several sites have yielded points with impact damage, still in small quantities, the proportion of points being rather low: Cova Eiros (Lazuen *et al.*, 2011; Lazuen 2012b), Cueva Morín, El Castillo, La Verde, Lezetxiki (Lazuen, 2012a, 2012b), Arlanpe (Rios-Garaizar, 2013), Axlor (Rios-Garaizar, 2016), Abri del Pastor (Galvan Santos *et al.*, 2007-2008), and to a lesser extent Amalda (Rios-Garaizar, 2010).

Finally, in Italy, six Mousterian points from the site of Oscurosciuto bear evidence of impact (Villa *et al.,* 2009), as does a convergent side scraper in quartz from the cave of Ciota Ciara (Daffara *et al.*, 2014). A Levallois point bearing an impact fracture was reported at the site of Asolo, which yielded a proboscidian carcass in association with several flint artefacts (Mussi, Villa, 2008); however, the step terminating bending fracture is only 0.8 mm, very small by the criteria commonly applied (see Part I).

The presence, at Beauvais (Coudenneau, 2013) and in layer D at Mandrin (Metz, 2015), of fractures interpreted as evidence of impact or potential impact on pseudo-Levallois points, may be reasonably called into question given their limited length, substantial thickness, and overall considerable mass. These points constitute pieces that are *a priori* little suited to hunting. A methodological revision may be necessary, as it seems possible that the damage observed on these pieces is the result of an untested mode of use other than hunting or a natural phenomenon other than trampling (the effects of which have been well documented).

The very anecdotal presence or even the total absence of points that clearly show signs of impact in certain regions, like southwestern France, would seem to indicate that certain groups used, primarily or exclusively, other forms of hunting weapons, such as spears or points made of wood, and/or made use of traps in the form of cliffs or pits. As for other regions, with the exception of layer E at Mandrin, we are in agreement with L. Metz that the bibliographic data on impact damage is to be regarded with caution because they are frequently the result of an "estimate that is optimistically high for this phenomenon, which is little evidenced in the archaeological assemblages of the Eurasian Mousterian" (Metz, 2015: 15). Doubts are often raised regarding the actual function of the points presented as impact-damaged due to the small number of such pieces, which may suggest possible taphonomic convergence (Pargeter, 2011; Rots, Plisson, 2014; Part II, chapter 2.3). To this can be added the scarcity of photographic evidence, the poor quality of the photographs that are sometimes provided, the diagnostic criteria employed, which are often not clearly presented, and even problems of terminology (Coppe, Rots, 2017).

Our analyses and our review of the available literature have raised one point that is cause for particular caution, which has also been articulated by L. Metz: the absence or extreme rarity of impact damage on points that have a morphology compatible with use as hunting weapons, while, in contrast, damage interpreted as the result of presumed impact is present on pieces with an array of morphologies, sometimes thick and slightly pointed.

B - The exploitation of carcasses

a - Summary of the use-wear data

Of the 424 active zones identified on which activity was determined, 279 are related to butchery activities (table 51). In a broad sense, this activity clearly dominates the spectrum of activities performed at the study sites. It has been identified at all of the study sites subjected to comprehensive analysis (table 62), at frequencies that are variable but always substantial, especially if we include that the tools used in scraping hard animal materials could correspond to a phase of butchery (see discussion below).

Cutting accounts for 92 % of the active zones if we include those that served both in cutting and another mode of activity (scraping or percussion) (figure 211), percussion represented in only 8 % of cases. The latter action is perhaps slightly underestimated, as there is a substantial number of such pieces that were used on materials that are medium-hard to hard that could have been wood or carcasses (15 flake cleavers from Abri Olha I and II, El Castillo and Gatzarria).

Series	Number of active zones used for butchery by cutting	Number of active zones used for butchery by percussion	Number of active zones used for butchery by cutting and scraping	Number of active zones used for butchery by cutting ad percussion	Number of active zones possibly used for butchery by scraping hard material	Total number of active zones	Frequency (%)
Bayonne le Prissé (PM1)	10					10	100
Bayonne le Prissé (PM2)	4					5	80
Chez-Pinaud (US 06 and 07)	92	3		1	4	170	59
Coudoulous (layer 4)	2		26		3	64	48
Fonseigner (Dsup)	30				(1)	46	65
Grotte du Noisetier	17			1		21	86
Les Fieux (layer K)	18	1			21	52	77
Mauran (XV 2 / layer 2)	28				9	57	65
Saint-Césaire (level Egpf)	18	5				27	85

Table 62 - Number of active zones interpreted as having served in butchery and the frequency of this activity according to the assemblages studied (including only those assemblages subjected to complete analysis).

As it is particularly difficult to assign a tool used in butchery to a precise butchery task, we constrain ourselves here to discussing the results of use-wear analysis in terms of mode of action (cutting, percussion, scraping) rather than to specific acts or phases of butchery.

For the same reasons enumerated in the preceding chapter (Part II, chapter 4.2), we have not included the results of several studies that we consider to have questionable methodologies: La Quina (Hardy, 2004), Payre (Hardy, Moncel, 2011), Abri du Maras (Hardy *et al.*, 2013), Inden-Altdorf (Pawlik, Thissen, 2017). The results of studies conducted in the 1980s, included in the comparisons, must also be approached with some caution given the concerns that have since been raised about their results (see Part II, chapter 4.1).

b - Butchery by cutting

Cutting has been identified on 257 active zones. Certain of these zones present, in addition to traces of cutting, traces linked to use in another mode of action, such as scraping (at Coudoulous, 26 active zones) and percussion (two pieces, at Grotte du Noisetier and at Chez-Pinaud). Butchery by cutting is evidenced in high proportions at all of the sites that were subjected to comprehensive analyses (table 62), as well as on a flint biface at Combe Brune 2, two flint bifaces at La Conne de Bergerac and six points at Payre.

Traces of cutting were detected on the different materials studied, with the exception of ophite; only flake cleavers in this material were analysed and showed traces of percussion. Pieces made of flint, quartzite, schist, lydite, and sandstone-quartzite were thus used as knives in butchery (table 63).

The tools interpreted as butchery knives in our study assemblages present varied techno-typological characteristics (table 64, figures 217-226): unmodified flakes from bifacial reduction, side scrapers (some of which were made on debitage flakes), bifaces, denticulates, and different types of points, dominated by pseudo-Levallois points. Three additional active zones on bifaces that were used to cut hide, based on the pointed morphology of the pieces and the presence of a second active zone used in butchery, could have been used in skinning rather than in hide-processing (see Part II, chapter 2.2.C; figures 235[h]-236). Other categories less frequently identified as butchery knives include: Clactonian notches (one at Mauran and one at Les Fieux), retouched flakes (one at Mauran and one at Les Fieux) and endscrapers (two at Les Fieux). Pieces that were used in cutting and in scraping include flakes (21 active zones), two side scrapers, and one backed knife, all in quartz-quartzite and all from the site of Coudoulous. As for pieces associated with both cutting and percussion, there is one naturally-backed knife in flint (Chez-Pinaud) and one flake in schist (Grotte du Noisetier).

We have not detected evidence for cutting – and in a more general sense traces of continuous contact – on flake cleavers. Given the fact that these tools are for the most part not well enough preserved to have maintained traces of use other than those, very pronounced, traces tied to use in percussion, it is not impossible that certain flake cleaver edges were used in other modes of action, including in butchery-knive. Even so, our own experiments have shown flake cleavers to be of little use in precise cutting tasks due to their considerable dimensions and weight.

This variety of forms is present in each assemblage and could reflect the employment of diverse butchery activities (figures 217-227):

- at Bayonne le Prissé (figures 217-218[a-b]), flakes, a pseudo-Levallois point, and bifaces from the PM1 assemblage, a Mousterian point (perhaps two) and two side scrapers in the PM2 series;
- at Chez-Pinaud (figures 219-222), unmodified flakes from biface manufacture, side scrapers on two categories of flake, bifaces, pseudo-Levallois points, denticulates, a backed knife, and a Levallois point;

	Flint	Quartzite	Quartz or quartzite	Ophite	Schist	Lydite	Sand-stone / quartzite	Undetermined	Total	Total per activity
WOOD PROCESSING										
Woodworking (longitudinal motions)	0		5						5	68
Probable woodworking (longitudinal motions)	13	1	3						17	
Woodworking (scraping)			6						6	
Probable woodworking (scraping)	23		9						32	
Probable woodworking (percussion)	3	2		3					8	
ANIMAL MATERIAL PROCESSING										
Hunting points			2						2	2
Butchery, cutting (+ scraping at Coudoulous)	47		26				1		74	279
Probable butchery (cutting)	57	1	5			1			64	
Butchery, cutting (non micro-polish)	77	20	5		7	2			111	
Probable heavy butchery (cutting)	4	1	1						6	
Probable heavy butchery (percussion)	9	9		3				1	22	
Probable butchery (cutting + percussion)	1								2	
Hide working (cutting)	20		1						21	34
Hide working (scraping)	7	1	2						10	
Probable hide working (piercing)	1	1							2	
Hide working (mixed action)	1								1	
Scraping of a hard and organic material (bone)	26	2	12			1			41	41
UNDETERMINED ACTIVITIES										
Undetermined activity (cutting)	0	1	1						2	68
Undetermined activity (scraping)	7	1							9	
Undetermined activity (piercing)	19	1	1						21	
Undetermined activity (intermediate piece)	2								2	
Undetermined activity (percussion)	1	12		3					16	
Undetermined activity (mixed motion)	1								1	
Undetermined activity + undetermined motion	9		6			2			17	
Total	**328**	**53**	**85**	**9**	**9**	**6**	**1**	**1**	**492**	**492**
%	**66.8**	**10.8**	**17.0**	**2.0**	**2.0**	**1.0**	**0.2**	**0.2**	**100**	

Table 63 - Number of active zones by raw material on pieces bearing traces of use, according to the activities identified (excluding traces of undetermined origin and zones used on mineral materials).

	Number of active zones	%
Unretouched flakes (excepted manufacturing and resharpening flakes)	100	39
Backed pieces with an unretouched edge (cortical, core edge or retouched back)	14	5
Levallois points	2	1
Pseudo-Levallois points	15	6
Mousterian points	3	1
Denticulates	26	10
Clactonian notches	2	1
Scrapers	33	13
Scrapers on biface manufacturing flakes	5	2
Retouched flakes	2	1
Bifaces	25	11
Endscrapers	2	1
Limace	1	0,4
Biface manufacturing flakes	24	9
Resharpening and notching flakes	3	1
Total	**257**	

Table 64 - Types of tools interpreted as butchery knives. See Annex 1 for the literature references.

- at Fonseigner (figure 224), flakes from full debitage and from core preparation and maintenance, a Levallois point, side scrapers, Mousterian points, and bifaces;
- at Grotte du Noisetier (figure 218[a-f]), flakes from full debitage (including a Levallois flake), a core-edge flake, ordinary flakes, and side scrapers;
- at Les Fieux (figure 225[a-c]), a Levallois flake, pseudo-Levallois points, ordinary flakes, end-scrapers, denticulates, a notched piece, and a retouched flake;
- at Mauran (figure 226), denticulates, unmodified flakes, pseudo-Levallois points, a side scraper, a notched piece, a retouched flake, and a *limace*;
- at Saint-Césaire (figure 227), flakes from full debitage, core-edge flakes, naturally-backed knives, an unmodified flake, backed flakes, denticulates, and notched pieces (retouching and recycling flakes).

The active zones are more often unmodified (60 %, 154 zones) than retouched. The modified edges, whether on bifaces, denticulates, or scrapers, bear removals that range from shallow to semi-abrupt. The edge angles are moderate, with values usually below 50°. The active zones are long, and, at the scale of a single assemblage, longer than those used in scraping. Preference for a long cutting-edge may have been an important element in the selection of tools to be used as knives in butchery. At Chez-Pinaud, for example, the biface manufacturing flakes that were selected were amongst those with the longest cutting edges (Claud, 2008, 2014a). The morphology of the active zones in plan view can be pointed, convex, rectilinear, or denticulated. The active zones also frequently display a zone of convergence (figures 217-227), on shaped tools, retouched pieces, and unmodified pieces alike. This might be in the form of a point or angle, situated in the middle of the active zone (off-set flakes, denticulates) or at an extremity (backed knives, unmodified flakes), adjoining the platform, for example. This angle, point, or tooth, in the case of denticulates, facilitated penetration of the tissues and concentrates the force in a sharp and precise cutting zone. These characteristics (outline, angle of cutting-edge) make for tools that are both penetrating and sharp, and therefore highly effective in butchery. Tool profiles are often rectilinear, but can also be concave, convex, or sinuous. We have observed in experimental butchery that variations in this feature have little impact on the performance of butchery activities, and more generally on the cutting of a soft material, though a rectilinear outline is important for sawing more hard materials. The cross-section is usually biplanar, sometimes plano-concave (denticulates), or slightly plano-convex (certain scrapers and bifaces). The presence of a backed or a dulled prehension zone is frequent. Backing can be natural, the result of debitage or retouching, or even the product of very abrupt, short retouch creating a narrow backing, as on certain flakes from Saint-Césaire. A combination of natural / debitage backing and retouch backing is sometimes observed. This abrupt section may (or may not) be associated with a platform that might complete the prehension zone. In the case of bifaces, a natural or abruptly-retouched butt often forms the prehension zone. Even so, the presence of a feature that might function as a backing is far from systematic: it is most notably absent on the very large majority of biface manufacturing flakes from Chez-Pinaud (a single one presents a combined natural / retouched backing), from certain very symmetrical bifaces (at Chez-Pinaud, notably) and from a considerable number of unmodified and retouched tools at Fonseigner (scrapers, flakes, points) (figures 219-224). Given that the presence of a backing allows for greater force to be applied, the tools that lack backing could have served for lighter cutting activities, precise and occasional work, or they could have been hafted; the use of a protective piece of hide could also be envisioned. It is also at these two sites that a few pieces were identified that bear traces compatible with hafting: two Mousterian points and a convergent side scraper (Part II, chapter 2.4). With regard to the biface manufacturing flakes, their low cutting angle (between 20° and 30°) makes their edges fragile and ill suited to cutting activities that involve the application of force and regular contact with harder materials. Retouching them into scrapers certainly renders them more resistant, resulting in edge-angles that measure between 30° and 40°.

Bayonne le Prissé PM1
(photographs: EC)
a - 21 737, flint
b - 12 093, flint
c - 22 329, flint
d - 21 715, flint
e - 20 746, flint
f - 22 302n, flint
use: cutting a soft to medium-hard material

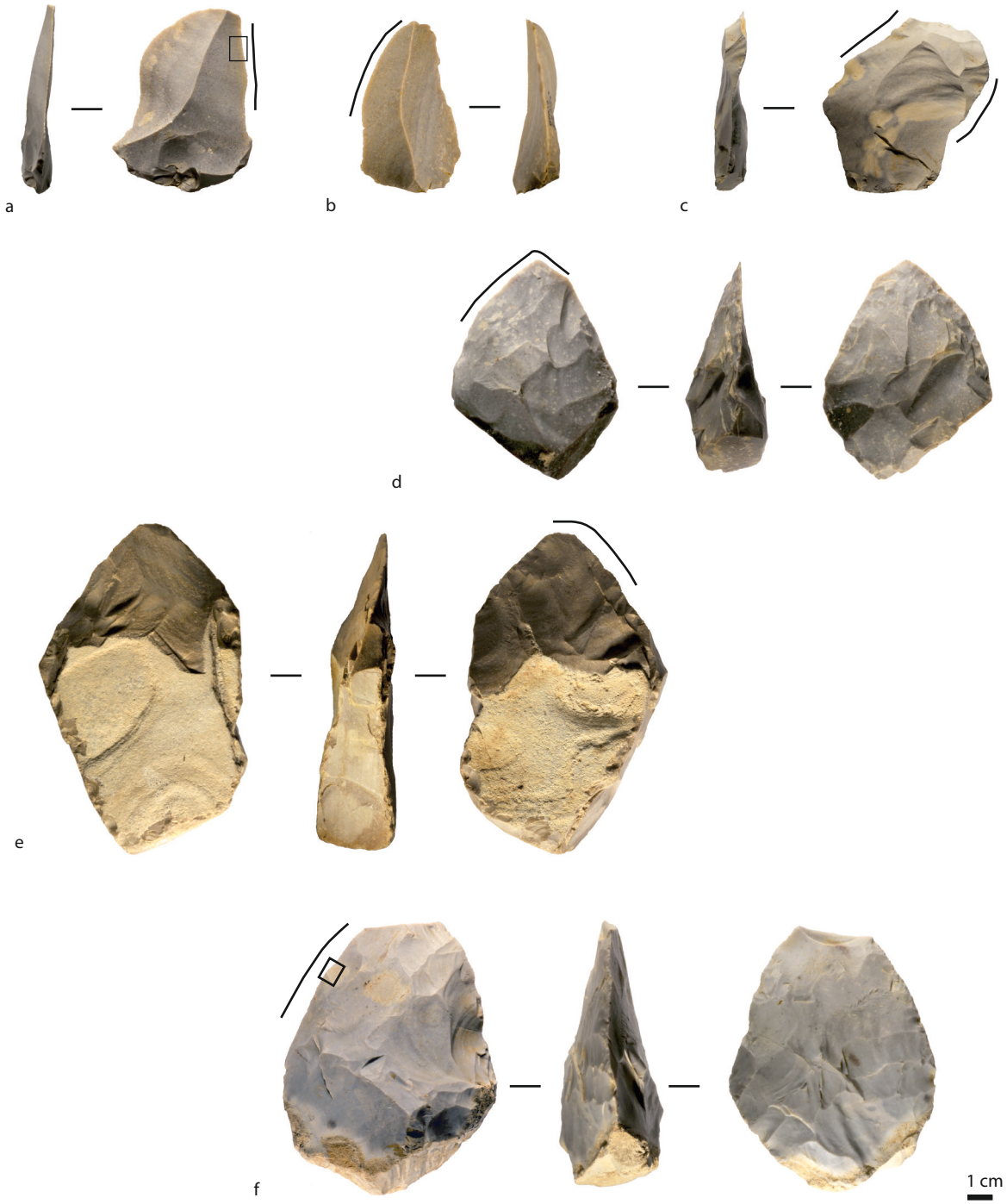
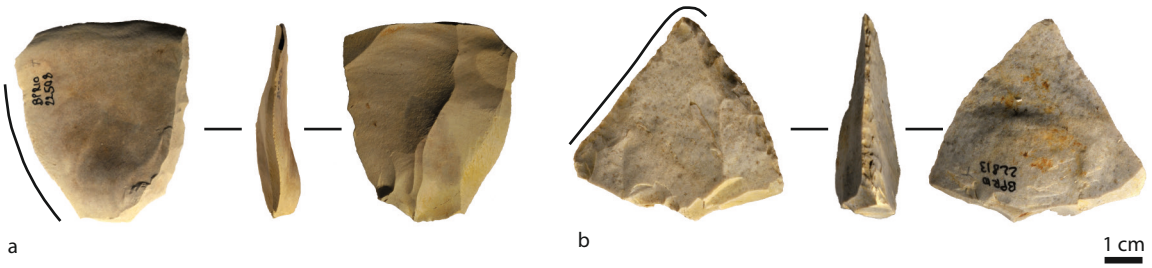


Figure 217 - Unmodified flakes and bifaces from the site of Bayonne le Prissé PM1 used or probably used in cutting in the context of butchery. The black rectangles indicate the locations of the photographs of the use-wear traces presented in figure 172[a-b] (CAD: É. Claud and M. Coutureau).

Bayonne le Prissé PM2
(photographs: EC)
a - 22 508, flint
b - 22 813, flint
use: cutting a soft to medium-hard material



Grotte du Noisetier
(photographs: EC; drawing: P. Allard)
a - NS 09 C14 c2S 226, quartzite
b - NS13 E11 c1 142, schist
c - NS07 C15 c2 262, lydite
d - 65NS 16C 1 51, quartzite
e - 65NS 16 D1 44, schist
f - NS 05 D13 c1 134, quartzite
use: cutting a soft to medium-hard material

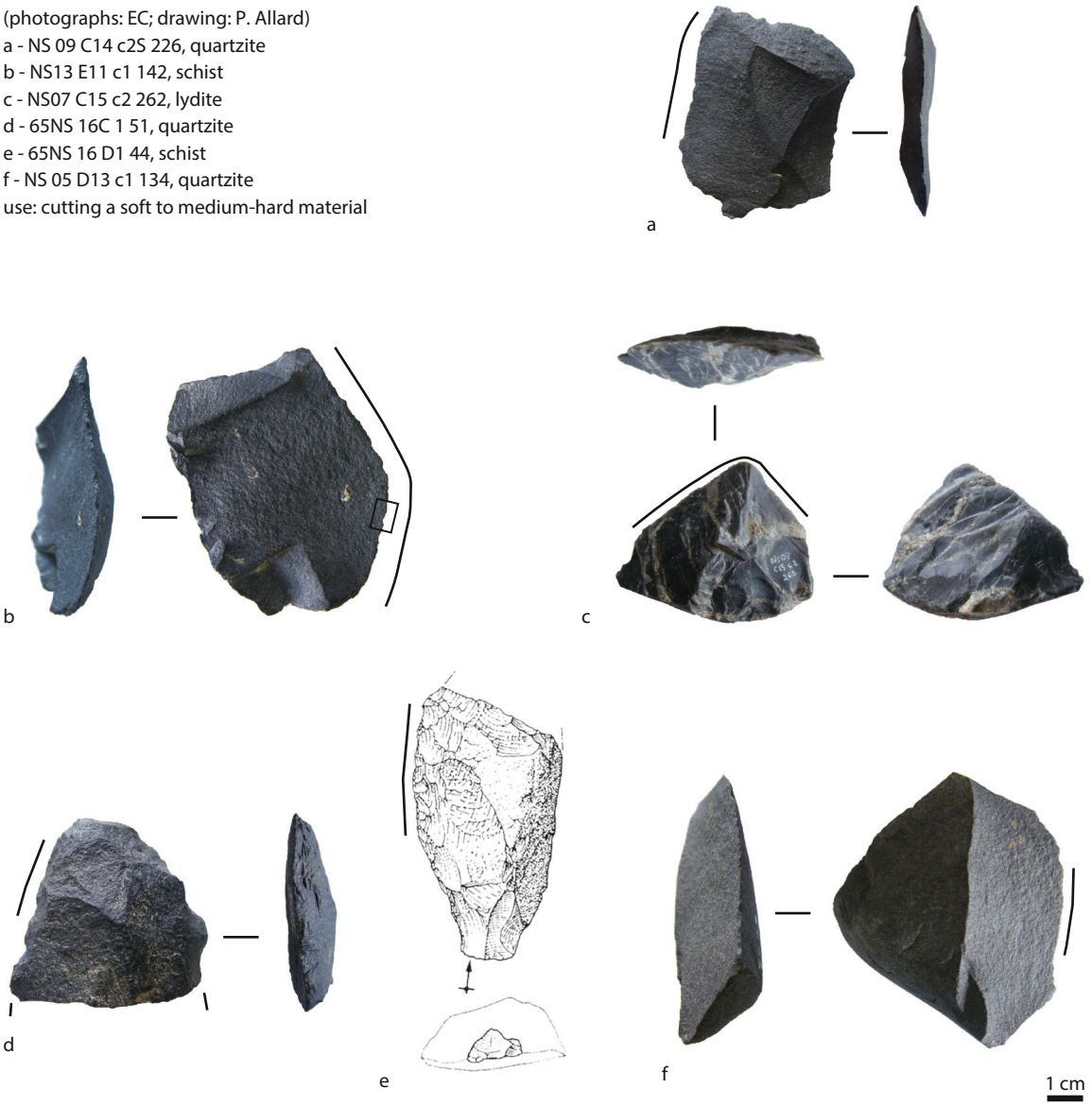


Figure 218 - Unmodified flakes and retouched tools from the sites of Bayonne le Prissé PM2 and Grotte du Noisetier, used or probably used in cutting in the context of butchery. The black rectangle indicates the location of the photograph of the use-wear traces presented in figure 174[c] (CAD: É. Claud and M. Coutureau).

Chez-Pinaud
(photographs: EC; drawing: S. Pasty)
a - CPN E14 965, flint
b - CPN E19 608, flint
c - CPN D19 927, flint
use: cutting a soft to medium-hard material
d - CPN E16 538, Turonian flint
e - CPN E14 636, flint
f - CPN F14 52, flint
g - CPN E16 711, flint
use: cutting resistant meaty materials

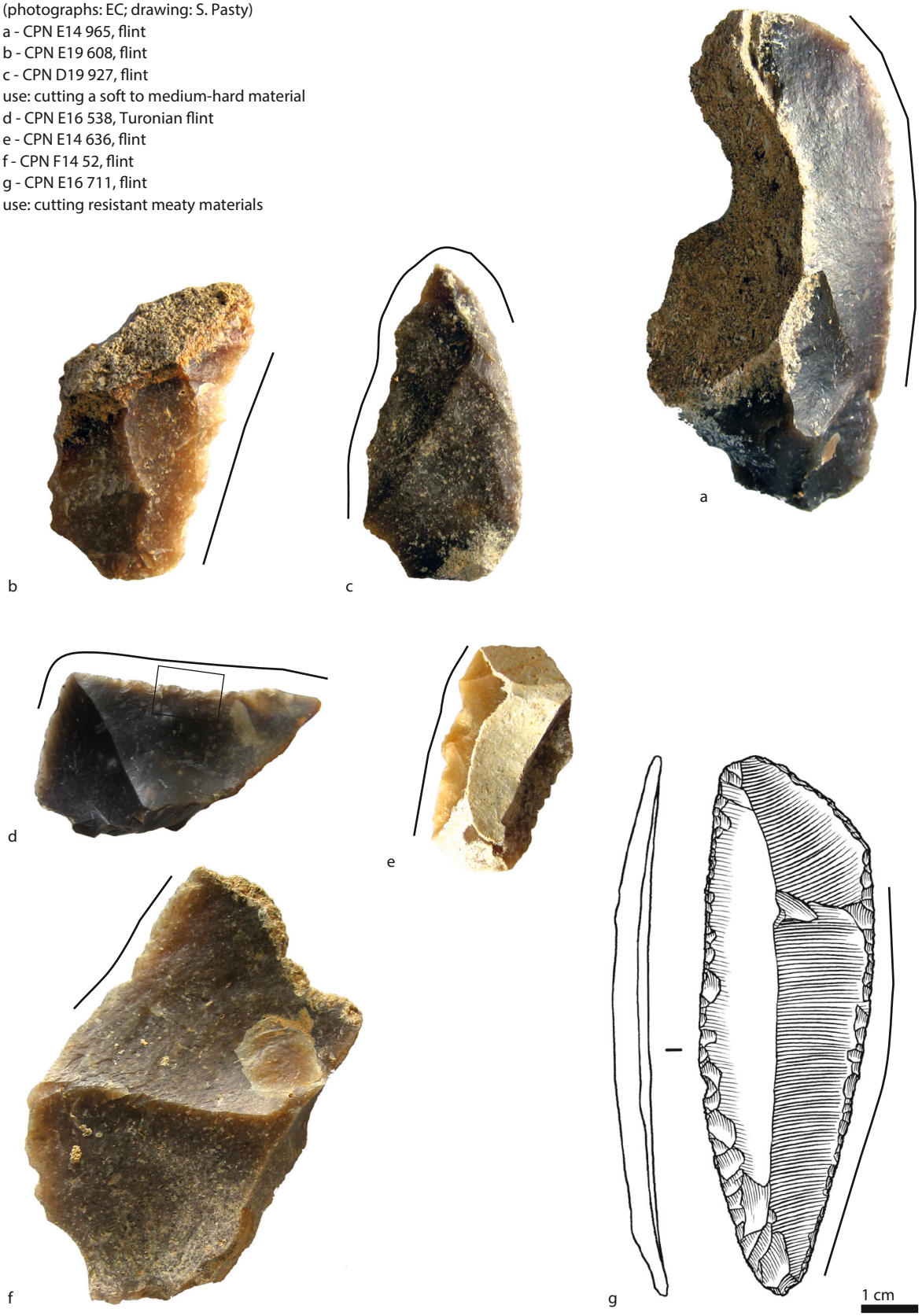


Figure 219 - Unmodified flakes and retouched tools from the site of Chez-Pinaud used or probably used in cutting in the context of butchery (continued in the next figure). The black rectangle indicates the location of the photograph of the use-wear traces presented in figure 172[c] (CAD: É. Claud and M. Coutureau).

Chez-Pinaud
(photographs: EC; drawing: S. Pasty)
a - CPN E18 32, flint
use: cutting meat
b - CPN D19 880, flint
c - CPN E14 701, flint
d - CPN E15 164, Turonian flint
use: cutting a soft material
e - CPN D19 854, flint
use: cutting a soft (G) and meaty (D) material
f - CPN E12 289, flint
g - CPN D16 343, Turonian flint
use: cutting a soft to medium-hard material

Figure 220 - Unmodified flakes and retouched tools from the site of Chez-Pinaud used or probably used in cutting in the context of butchery (end). The black rectangle indicates the location of the photograph of the use-wear traces presented in figure 172[d] (CAD: É. Claud and M. Coutureau).

Chez-Pinaud
(drawings: S. Pasty and F. Brenet)
a - CPN F15 111, sandstone-quartzite
use: cutting meat
b - CPN E18 30, flint
use: cutting a soft to medium-hard material
c - CPN F15 117, flint
d - CPN E14 545, flint
use: cutting a cutaneous or meaty material

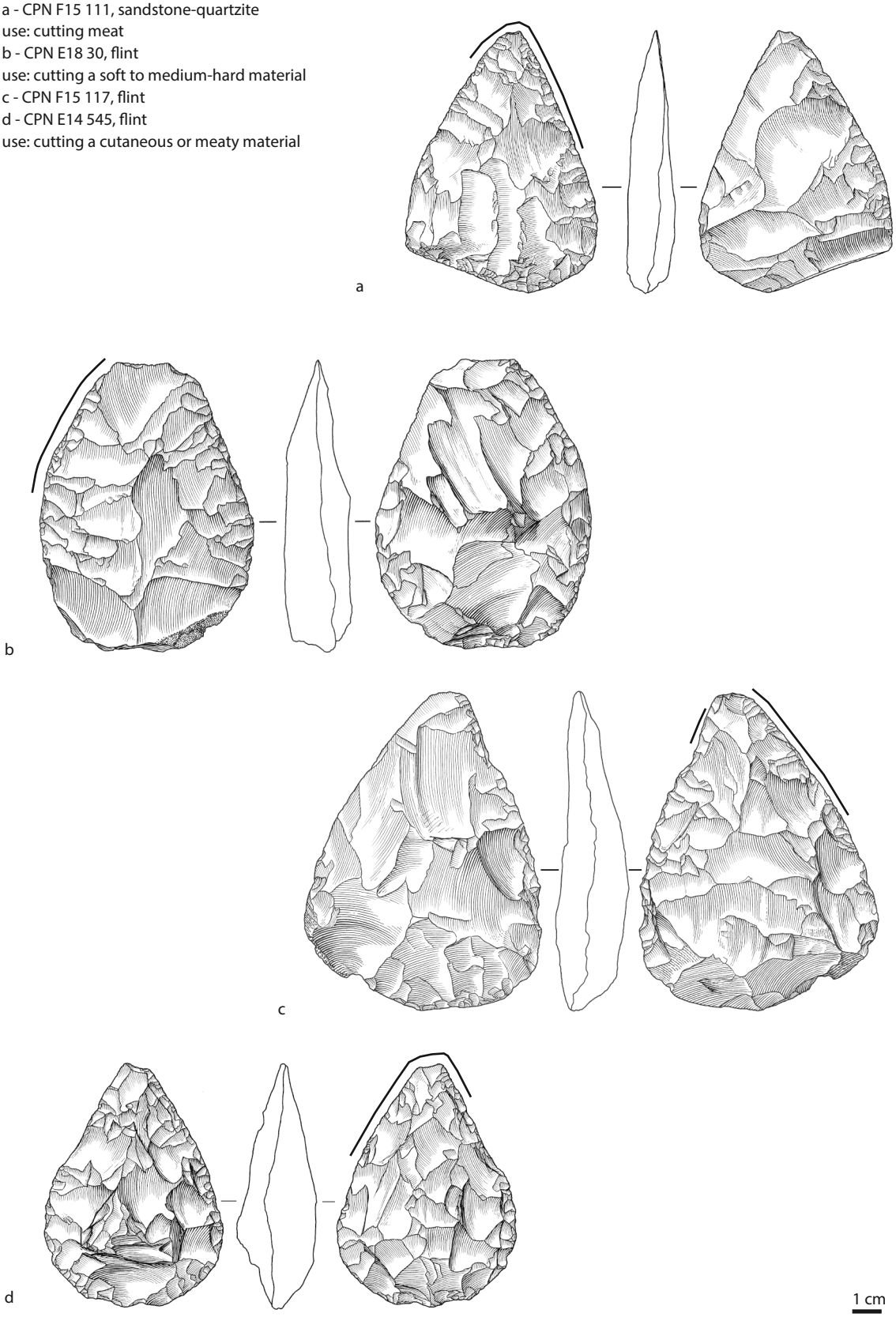


Figure 221 - Bifaces from the site of Chez-Pinaud (continued in the next figure) used or probably used in cutting in the context of butchery (CAD: É. Claud and M. Coutureau).

Chez-Pinaud
(drawings: S. Pasty and F. Brenet)
a - CPN E13 624, flint
use: cutting soft material
b - CPN F16 73, flint
use: cutting soft to medium-hard material
c - CPN E14 301, flint
use: cutting cutaneous or meaty material
d - CPN E15 324, flint
use: cutting soft to medium-hard meaty material

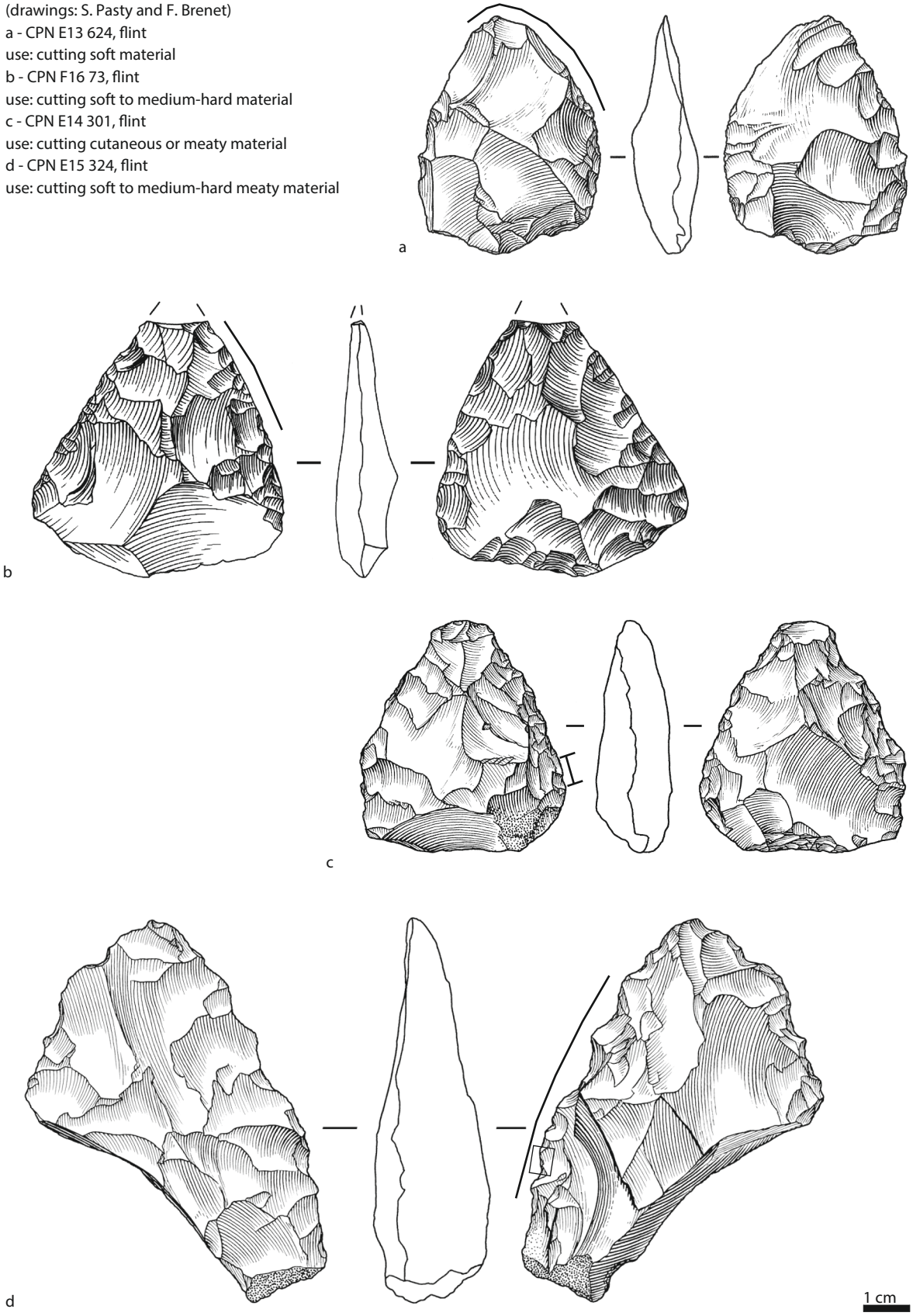


Figure 222 - Bifaces from the site of Chez-Pinaud (end) used or probably used in cutting in the context of butchery (CAD: É. Claud and M. Coutureau).

Combe Brune 2
(photographs: EC)
CB2 61010, flint
use: cutting a soft material

La Conne de Bergerac
(drawings: F. Brenet; photographs: EC)
a - BDS 01, s41 c2/3 6073, flint
use: cutting a soft material
b - BDS Z2 6072, flint
use: cutting cutaneous or meaty materials

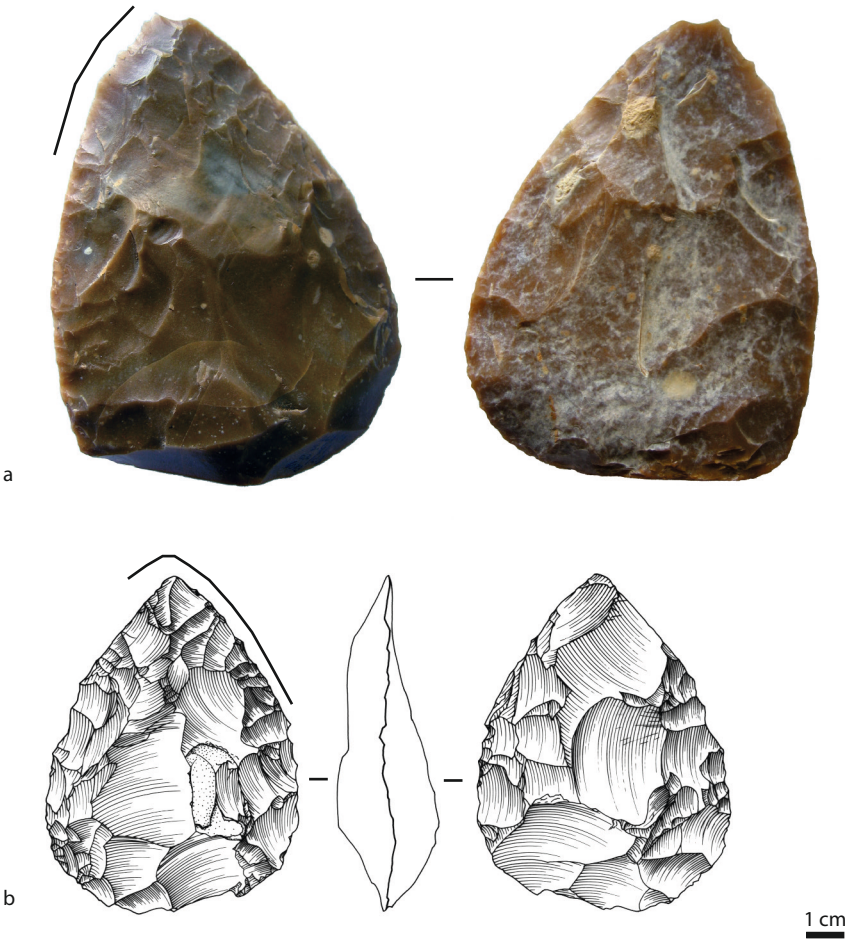


Figure 223 - Bifaces from the sites of Combe Brune 2 and La Conne de Bergerac used or probably used in cutting in the context of butchery (CAD: É. Claud and M. Coutureau).

Fonseigner
(drawings: J.-M. Geneste)
a - Fons 77 Dsup 13 30, flint
b - Fons A6 01 Dsup 3, flint
c - Fons 77 Z2 Dsup 03, flint
use: cutting meat
d - Fons 77 Z4 Dsup 01 12, flint
use: cutting soft to semi-hard materials like hide and meat
e - Fons 77 A4 85 Dsup 14, flint
use: cutting soft to medium-hard material
f - Fons Z3 106 Dsup 9, flint
use: cutting soft to medium-hard materials like hide and meat
g - Fons 77 A5 65 Dsup 11, flint
h - Fons 77 22 Dsup 13, flint
i - Fons 3 Z1 Dsup 4, flint
use: cutting resistant meaty materials

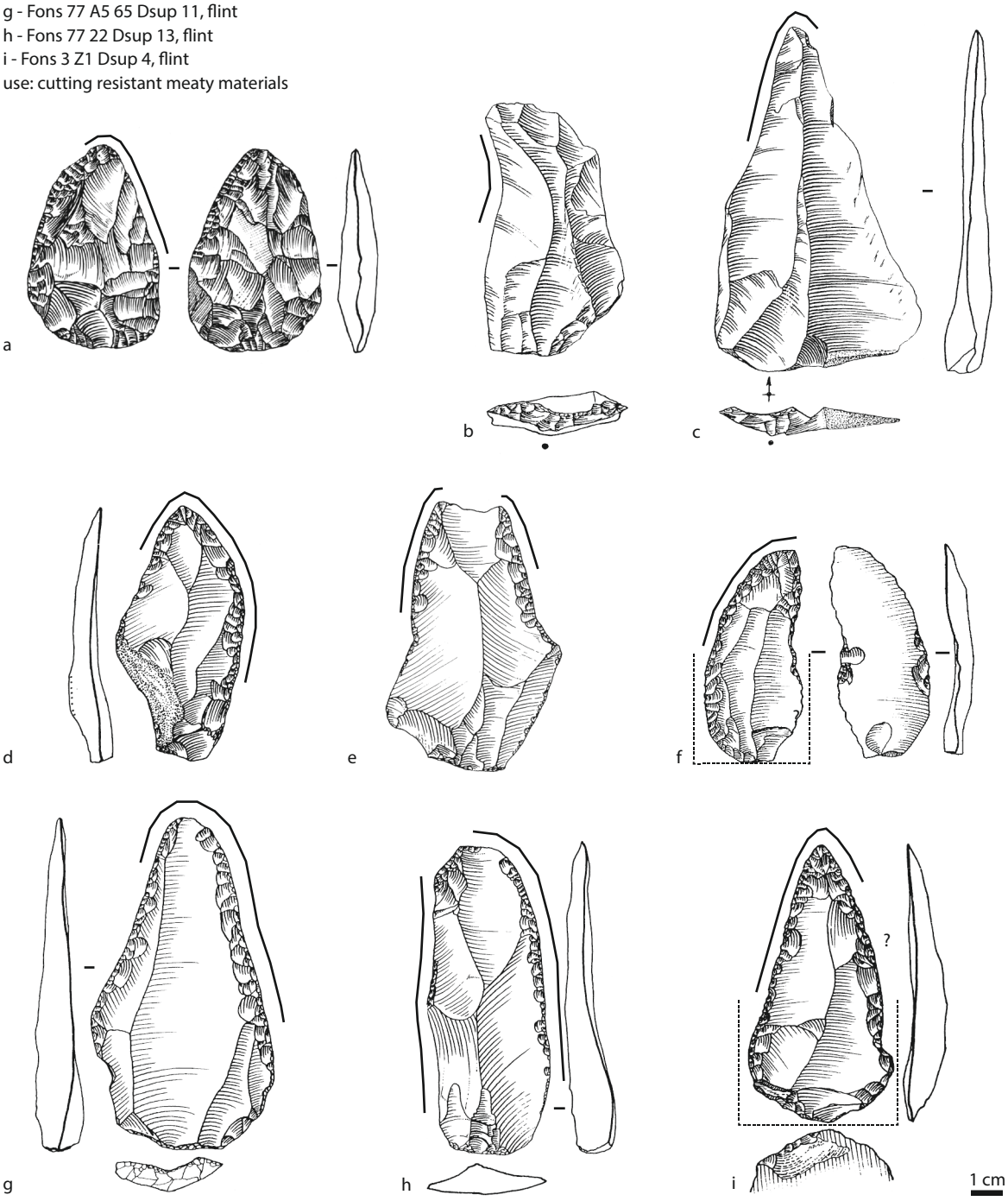
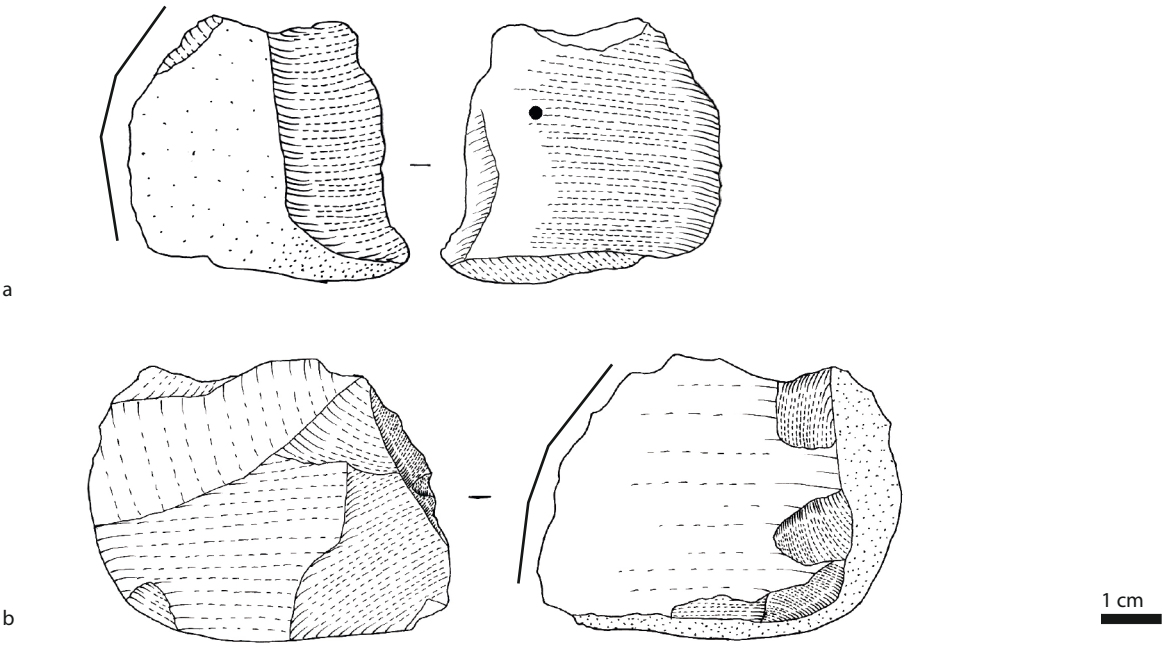


Figure 224 - Biface, unmodified flakes and retouched tools from the site of Fonseigner used or probably used in cutting in the context of butchery (CAD: É. Claud and M. Coutureau). The dotted zone indicates the potential location of hafting.

Coudoulous
(drawings: FV)
a : Cou I J 10 6b6, quartz
use: cutting meat and gripping contact with hide (point)
b : COU 4 #65, quartz
use: cutting meat



Les Fieux
(photographs: CT)
a - K 30 068, quartzite (side scraper)
use: cutting a soft material
b - K 30 859, flint
c - K 35 610, flint
use: cutting a soft to medium-hard material

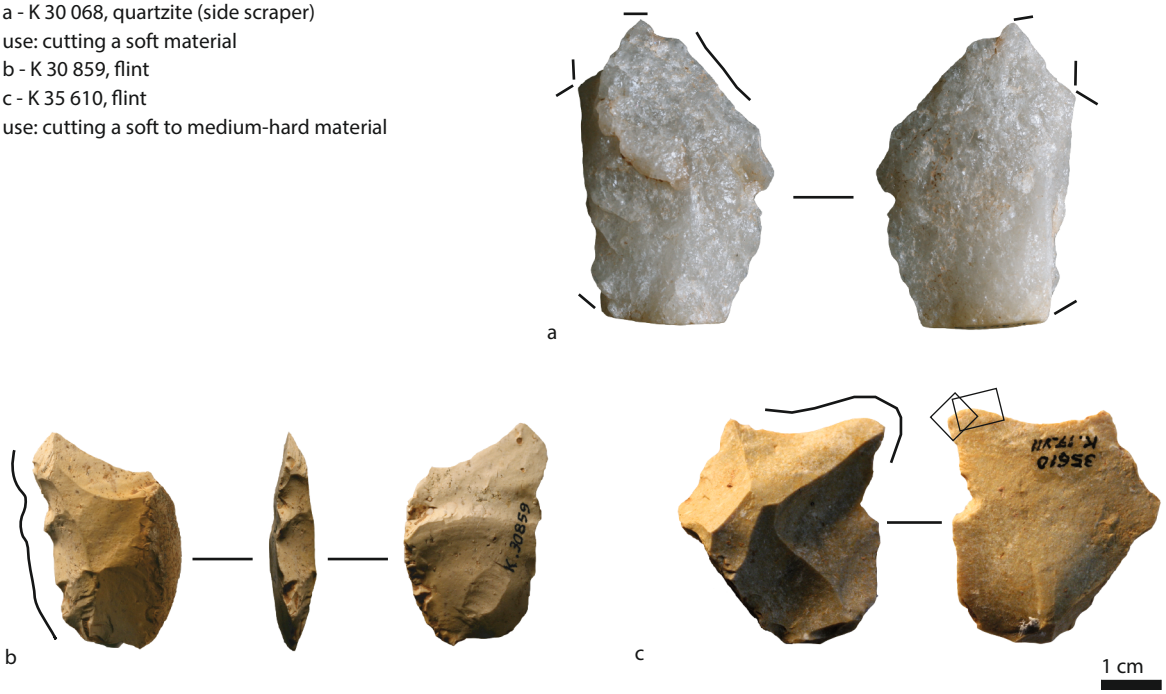


Figure 225 - Unmodified flakes and retouched tools from the sites of Coudoulous and Les Fieux used or probably used in cutting in the context of butchery. The black rectangles indicate the locations of the photographs of the use-wear traces presented in figure 174[a-b] (CAD: É. Claud and M. Coutureau).

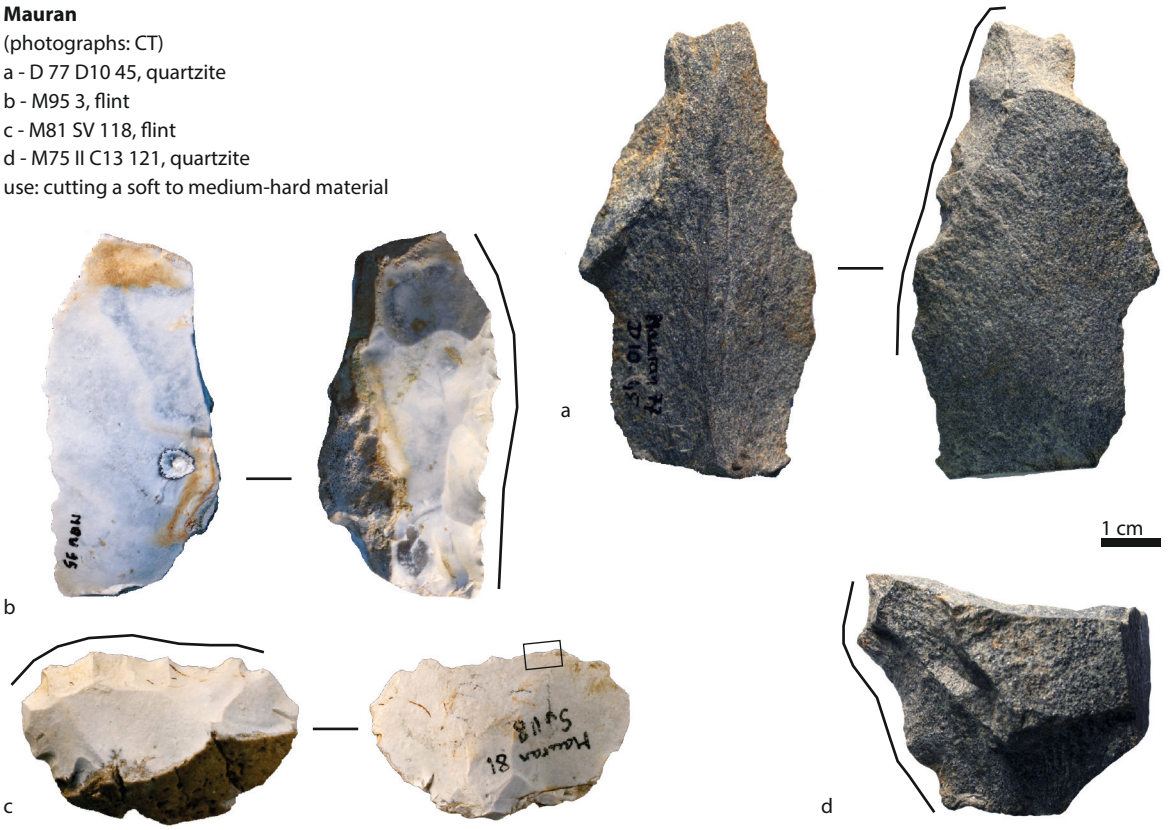


Figure 226 - Denticulates from the site of Mauran used or probably used in cutting in the context of butchery. The black rectangle indicates the location of the photograph of the use-wear traces presented in figure 174[e] (CAD: É. Claud and M. Coutureau).

Publications noting the presence of tools in the Middle Palaeolithic of Western Europe that served or could have served in cutting for butchery purposes are numerous (table 65). In fact, evidence of this activity has been recognized in all of the assemblages subjected to comprehensive analysis, with the exception of Corbiac, Pech de l'Azé I and IV, Grotte du Renne, and Les Pradelles (Anderson-Gerfaud, 1981; Beyries, 1987a), and these studies are not without methodological problems (see Part II, chapter 4.1). Aside from the open-air site of Corbiac, these sites have preserved abundant faunal remains that indicate substantial butchery activities, evidenced directly by the numerous butchery marks on the bones (Costamagno *et al.*, 2006; Rendu, 2010; Hodgkins, 2012; Niven, 2013). At Les Pradelles in particular, occupation was focused on reindeer butchery (see Part II, chapter 3.1; Costamagno *et al.*, 2006; Meignen *et al.*, 2007; Rendu *et al.*, 2011). Thus, at this site, the absence of use-wear traces indicative of butchery does not accurately reflect the site function. It is possible that a certain number of the tools from these sites that were categorized as unused or used on an undetermined material were actually used in butchery. As noted elsewhere in this publication (see Part I), simple unmodified flakes make excellent butchery tools, and were often excluded from these use-wear analyses.

Some few sites in Western Europe provide evidence for the use of materials other than flint in the production of butchery tools: quartz at Tunnelhölle and Lurgrotte in Austria (Derndarsky, 2006; 2008), rock crystal at Champ-Grand in south-eastern France (one side scraper; Plisson, 2008), quartz and quartzite at Axlor, Cueva Morín, Cova Eiros and San Quirce in Spain (Lazuén, Gonzales-Urquijo, 2014; Lazuén, 2012a; Clemente-Conte *et al.*, 2012) and schist at Axlor and Cueva Morín

	Site	Tool types
England	La Cotte de Saint Brelade	scraper and biface resharpening flakes
Belgium	Rémicourt	elongated flakes
	Spy	Mousterian points
Netherlands	Maastricht-Belvédère (site J)	unretouched flakes
	Maastricht-Belvédère (site K)	Levallois points
	Maastricht-Belvédère (sites B-G)	core edge flakes and blades
Germany	Lehringen	Levallois flakes
	Lichtenberg	bifacial backed tools
	Sesselfelsgrotte	bifacial tools (among others), sometimes hafted
Austria	Lurgrotte	cortical backed knives
	Tunnelhölhe	unretouched flakes
Northern France	Attilly "Bois de la Bocquillière"	preferential Levallois flakes, retouched or not
	Beauvais "La Justice"	pseudo-Levallois points
	Bettencourt-Saint-Ouen	unmodified or retouched Levallois points
		unmodified or retouched Levallois points
	Biache-Saint-Vaast	short and non convergent scrapers
		Levallois flake, retouched Levallois point, simple, double and convergent scrapers (tools with asymmetric convergent edges, sometimes hafted)
	Corbehem	cortical backed knives
	Fresnoy-au-Val	Levallois point
	Havrincourt "Les Bosquets" (sector 2)	unretouched flakes, blades, cortical and retouched backed knives
	Havrincourt "Les Bosquets" (sector 1)	preferential Levallois flakes, retouched or not
	Hermies "Le Tio Marché" and "Champ Bruquette"	preferential Levallois flakes
		preferential Levallois flakes
	Le Pucheuil	"Le Pucheuil" flakes
	Riencourt-lès-Bapaume	unretouched blades
	Saint-Amand-les-Eaux	bifaces and biface manufacturing flakes (unmodified or retouched)
	Therdonne	Levallois points
South Western France	Bayonne Jupiter	unretouched flakes (various types: semi-cortical flakes, cortical backed flakes, core edge flakes, flakes from full debitage, pseudo-Levallois points), pseudo-Levallois point with a retouched back, scrapers
		scrapers, pseudo-Levallois, point, biface
	Bourg-Charente	unretouched flakes (cortical backed knives, core edge flakes, pseudo-Levallois points), retouched backed flakes, denticulate
	Bout des Vergnes	unretouched flakes, bifaces, scraper, backed knives
	Canolle	unretouched flakes, scraper, bifaces, mousterian point, retouched backed knife, biface manufacturing flakes
	Cantalouette II	undetermined
	Combe-Grenal (layers 3 or F)	cortical backed knife
	Grotte XVI	bifaces
	Chez-Pinaud (US 22)	Quina scrapers, scraper manufacturing flakes, retouching flakes, recycling flakes (retouched or not)
	La Mouline	unmodified and retouched flakes (full debitage flakes, core edge flakes, pseudo-Levallois points, cortical backed knives, semi-cortical flakes)
	Abri du Musée	pieces with tranchet blow, tranchet blow flakes
	Latrote	bifaces, denticulates, scrapers, mousterian points
	Les Bessinaudes	semi-cortical flakes, pseudo-Levallois points, cortical backed knives, flakes from full debitage, double scraper on an elongated flake, thinned piece, retouched flake, scrapers (including convergent ones)

	Site	Tool types
South Western France	Les Tares	scrapers with Quina retouch, retouching flakes
	Romentères	a flint flake
	Vaufrey	cortical backed knife and denticulates
	Vieux-Coutets	unretouched flakes from full debitage, scrapers, endscrapers
South Eastern France	Baume Vallée	unretouched flakes
	Champ-Grand	scraper (in rock crystal)
	La Combette	unretouched flakes, rare retouched flakes, with a straight delineation and a plano-concave section
	Pié-Lombard	cortical backed knives
Italy	Grotta Breuil (layers 3 and 6)	unretouched flakes, rare retouched flakes, often semi-cortical and with straight profile, biplanar section and various delineations
	Grotta Breuil (layer XX)	unmodified semi-cortical flakes, cortical backed knife (among others)
	Ciota Ciara cave	indet. (scrapers, mousterian points, notched piece?)
Spain	Abric Romaní (levels H, I, Ja)	flakes, denticulates, scraper
	Abric Romaní (level 0)	retouched Levallois point (traces on the unretouched edge), unretouched Levallois point
	Abric Romaní (level M)	unretouched flakes
	Amalda	unretouched flakes (including Levallois flakes)
	Arlanpe	undetermined
	Axlor	scraper resharpening flakes (unretouched)
	Bajondillo cave	unretouched flakes and blades (two with a retouched prehension area)
	Cova Eiros	unretouched flakes (quartz or quartzite)
	Cueva Morín (layer 16)	scraper resharpening flakes (unretouched), unmodified flake, retouched flake, quartzite scraper
	Cueva Morín (layer 18)	scraper resharpening flakes (unretouched)
	El Salt	unretouched flakes (semi-cortical flakes, Levallois flakes, core edge flakes, cortical backed knives)
	La Quebrada	Levallois micro-flakes
	San Quirce	unretouched flakes, choppers

Table 65 - Published data on Middle Palaeolithic assemblages in Western Europe that have yielded butchery knives, and the relevant types of pieces.

(Lazuén, 2012a; Lazuén, Gonzáles-Urquijo, 2014). None of the available publications indicate a particular raw-material economy, such as the preference for a specific material for the performance of particular butchery activities. At present, butchery marks on bone also provide no information relevant to these discussions.

The techno-typological characteristics of knives in our study samples seem to vary in line with different groups and technological traditions. Unmodified flakes are very often mentioned and derive from various methods of reduction: recurrent and preferential Levallois, micro-Levallois, Discoidal, lamellar, and the Le Pucheuil (secondary debitage) type. Unmodified butchery knives therefore display great variation in dimensions and morphologies: pseudo-Levallois points, backed core-edge flakes, cortically backed knives, Levallois flakes, Levallois points, semi-cortical flakes, Kombewa flakes, laminar flakes or blades. Flakes resulting from production (shaping, retouch, or recycling) of side scrapers – notably of the Quina type – and of bifaces or bifacial pieces also in some cases bear evidence of use in butchery (Frame, 1986; Geneste, Plisson, 1996; Coudenneau, 2005; Claud *et al.*, 2012; Claud, 2014a; Lazuén, Gonzáles-Urquijo, 2014; Bourguignon [ed.], in prep.).

Saint-Césaire
(drawing: CT; photographs: EC)
a - H4 (I) Egpf 27 28, flint
b - H5 (II) Ejpf 27, flint
c - G5 IV Egpf 27 263-30-43 3, flint
d - G5 (II) 27 269-76-73 3, flint
e - D4 III Egpf 28 276-61-50 6, flint
f - I4 (I) Ejpf 27, flint
use: cutting a soft to medium-hard material
abrupt marginal retouch

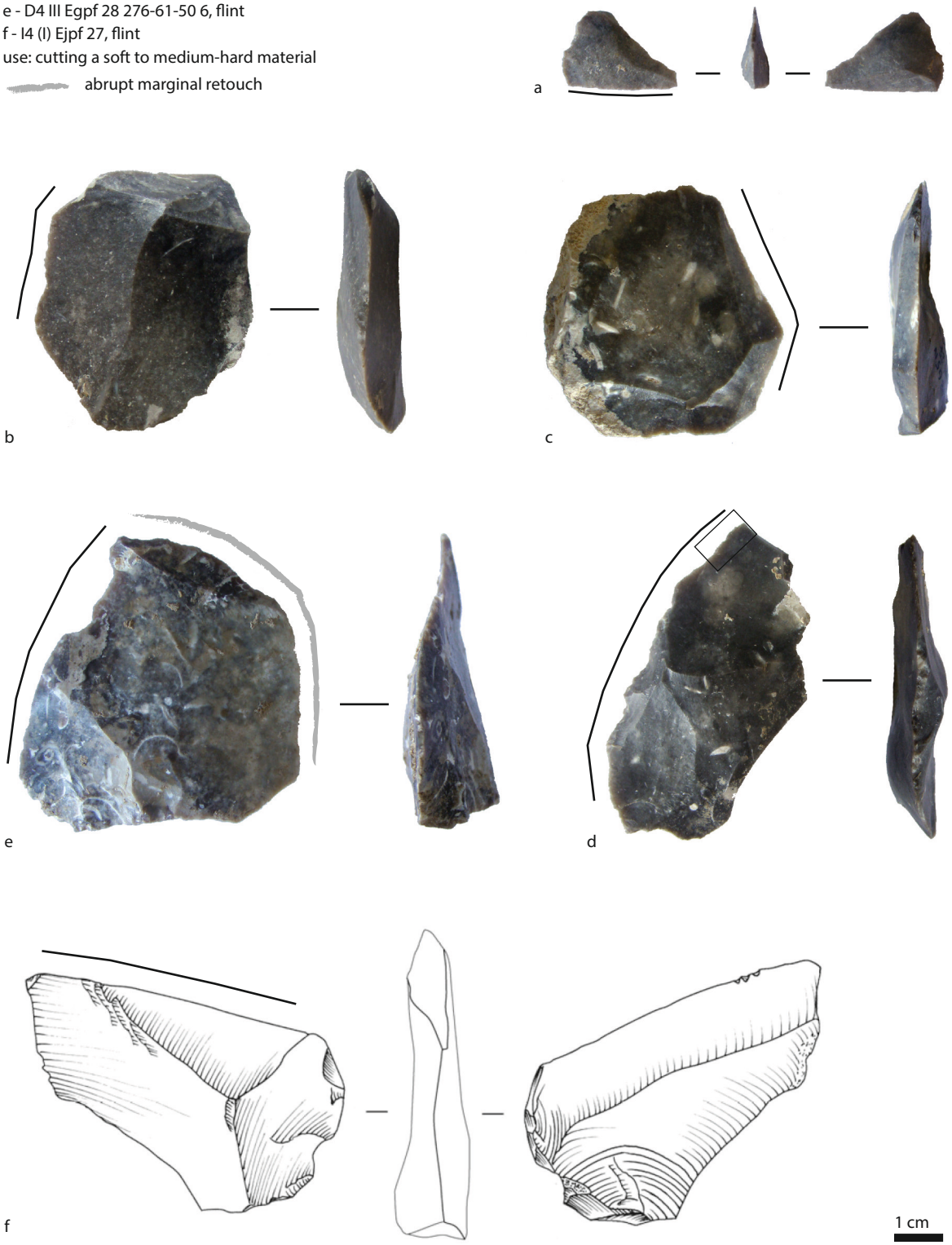


Figure 227 - Unmodified flakes (including resharpening flakes, a) and denticulates from the site of Saint-Césaire used or probably used in cutting in the context of butchery. The black rectangles indicate the locations of the photographs of the use-wear traces presented in figure 175[c] (CAD: É. Claud and M. Coutureau).

Shaped and retouched tools are also subject to great variation in form. In our study samples, traces of cutting in butchery activities were regularly observed on bifaces and bifacial pieces (Veil *et al.*, 1994; Soressi, Hays 2003; Coudenneau, 2005; Rots, 2009; Bernard-Guelle *et al.*, 2010, 2014; Colonge *et al.*, 2015; Ihuel [ed.], 2016; Bourguignon [ed.], in prep.). Side scrapers are frequently mentioned as butchery knives and made on a variety of blanks: Levallois flakes, flakes from Quina debitage, biface manufacturing flakes, flakes from side scraper resharpening / recycling, etc. The types of side scrapers are equally varied with some widely shared morphological characteristics, such as the presence of two convergent cutting edges, with two retouched edges or one edge left unmodified (Claud *et al.*, 2012; Rots, 2013; Chadelle *et al.*, 2016). Retouched Mousterian points and Levallois points used in butchery are rare, but do occur at Spy (Coudenneau, 2013), Biache-Saint-Vaast (Rots, 2013), Bettencourt-Saint-Ouen (Locht *et al.*, 2002), Canolle (Bourguignon [ed.], in prep.), Latrote (Bernard-Guelle *et al.*, 2010) and Abric Romaní, level 0 (Gauvrit Roux, 2013). Such is also the case for denticulates, used as butchery knives at just four sites: Grotte Vaufrey (Beyries, 1987a), Bourg-Charente (Connet *et al.*, 2016), Latrote (Bernard-Guelle *et al.*, 2010) and Abric Romaní (Martinez-Molina, 2005). At Abric Romaní, they were used in skinning, disarticulation, and probably defleshing (Martinez-Molina, 2005). Finally, the use of knapped cobbles in quartz and quartzite for the cutting of meat has been observed at one site, San Quirce (Clemente-Conte *et al.*, 2012).

The diversity of blanks used for making butchery tools can be seen across sites, regions, and time periods, but it can also be seen, as our study samples show, within the same assemblage. In fact, numerous sites that have been subjected to comprehensive lithic analysis contain butchery knives on varied blanks:

- Biache-Saint-Vaast: Levallois flake, retouched Levallois points, simple side scrapers, double side scrapers, and convergent side scrapers (Rots, 2013);
- Bourg-Charente: unmodified flakes (backed asymmetrical flakes, cotically backed knives), retouched backed knives, and denticulates in flint (Connet *et al.*, 2016);
- Canolle: unmodified debitage flakes, biface manufacturing flakes, side scrapers, bifaces, Mousterian points, backed knives (Bourguignon [ed.], in prep.);
- Les Bessinaudes: semi-cortical flakes, pseudo-Levallois flakes, cortically backed knives, flakes from full debitage, a double side scraper on an elongated flake, a thinned piece, a retouched flake, convergent side scrapers, side scrapers (Chadelle *et al.*, in prep.);
- Les Tares: Quina and non-Quina retouched side scrapers, backed knives, and scraper retouching flakes (Geneste, Plisson, 1996);
- Chez-Pinaud US 22: Quina side scrapers, flakes from side scraper manufacture – shaping, retouch, and decortication (Claud, *et al.*, 2012);
- Latrote: bifaces, denticulates, side scrapers, Mousterian points (Bernard-Guelle *et al.*, 2010, 2014);
- Bayonne Jupiter PM1: unmodified flakes (some semi-cortical or cortically backed knives and core-edge flakes), side scrapers, and a pseudo-Levallois point with knapped backing (Cologne *et al.*, 2015);
- Bayonne Jupiter PM2: side scrapers (certain used on the unmodified edge), a pseudo-Levallois point, and a biface (Cologne *et al.*, 2015);
- Abric Romaní: denticulates, flakes, a side scraper (Mártinez-Molina, 2005).

The active zones are rarely described in detail, but when they are, several features are frequently mentioned or directly observable in the photographs or drawings provided: the edges are frequently unmodified, the outlines in plan view are varied (convex, pointed, rectilinear, denticulate, irregular, ...), the cutting angle closed to half-open (between 25° and 50°), the profiles are frequently rectilinear, and the cross-sections often biplanar or plano-concave (for the latter details, see Lemorini, 2000; Claud *et al.*, 2012; Coudenneau, 2013; Claud *in* Goval *et al.*, 2013; Claud *in*

Chadelle *et al.*, in preparation; Claud, 2014a). With regard to the prehension areas, a considerable number of studies have shown the frequent but rarely systematic use of a natural zone (cortical or semi-cortical backing, platform) suited to use with a bare hand, notably on unmodified flakes (at Lugrotte, Maastircht-Belvédère site B-G, Le Pucheuil, Corbehem, La Cotte de Saint Brelade, Bourg-Charente, Grotte Vaufrey, Combe Grenal level 3 or F (13), Pié-Lombard, Bout des Vergnes, Canolle, La Mouline, Les Bessinaudes, Chez-Pinaud US 22, Les Tares, Bayonne Jupiter PM1 and PM2, Grotta Breuil XX). Several assemblages contain butchery tools with potential prehension zones prepared by retouch, sometimes in continuity with the platform or an overshot or cortical backing, often positioned opposite the active zone. The retouch is discrete, semi-abrupt to abrupt, and marginal to short. Sometimes simple rubbing was used to create a backed knife, more than a real retouch. The blanks are varied: flakes from Discoidal debitage (Bourg-Charente, Bayonne Jupiter PM1) or Levallois debitage, unmodified or retouched (Saint-Amand-les-Eaux, Havrincourt sector 1, Atilly, Hermiès, Canolle), biface manufacturing flakes (Saint-Amand-les-Eaux) and bifacial pieces (Lichtenberg). In contrast, traces of hafting have been observed on some of the knives from Sesselfelsgrotte, Biache-Saint-Vaast and on the majority of Levallois points from Bettencourt-Saint-Ouen that were used in butchery (Rots, 2009, 2015b).

The characteristics of butchery knives defined in our study sample are thus coherent with the published data for sites in Western Europe. Various raw materials, blanks, and types of tools were used (figure 239, table 70), but some strong trends can be observed with regard to morphology. The edges are most often unmodified and of low angle and, when they are retouched, the retouch is to semi-abrupt, maintaining an edge angle that is low to moderate (around 45°); the sides are often convergent or come to a point; prehension zones, natural or retouched, may be present, and it appears (to varying degrees of certainty) that certain pieces were hafted.

The diversity of raw materials used to these ends can be partly attributed to local availability. The diversity, notably typological, of butchery knives at the intra-site level could be explained by the following factors, or some combination of them:

- a functional complementarity of pieces, with different tools being used for different butchery operations, as J.-M. Geneste and H. Plisson (1996) have proposed for the assemblage at Les Tares on the basis of the morphological characteristics of the tools, unmodified and retouched, and more or less heavy and sharp;
- a specific function for tools like bifaces, a hypothesis that is supported by the technological skill necessary for their production, the longevity of these pieces, and their frequent transport at a regional / territorial scale (see Claud, 2008 for an overview and Part II, chapter 4.4.C);
- retouching or resharpening of active zones, in order to make them stronger and sharper, or more pointed. This could notably be the case for bifaces or bifacial scraper flakes, that were sometimes retouched into scrapers (Chez-Pinaud US 06/07 and US 22, Claud *et al.*, 2012; Claud *et al.*, 2014a), as their unmodified edges were thin and fragile (20°-25°); pseudo-Levallois points and core-edge flakes retouched into denticulates at Saint-Césaire, Mauran, and Les Fieux, or even certain side scrapers at Fonseigner. Additionally, the retouching of unmodified edges that bear traces of use in cutting fleshy material into denticulates has been observed on two notched pieces at Saint-Césaire and one denticulate that presents traces from cutting flesh on an unretouched portion interrupted by the denticulate retouch.

The inter-site techno-typological diversity of butchery knives, on the other hand, certainly reflects a diversity of technological traditions amongst Neanderthal groups. Let us take, for example, Les Fieux, Mauran, and Saint-Césaire on one hand and Chez-Pinaud US 06/07 on the other. Bison was the primary prey animal at all four sites, but the Neanderthals at the first set of sites used denticulates, while those at the second used scrapers and bifaces.

c - Butchery by percussion

Traces indicative of percussion against medium-hard to hard and hard organic materials were observed on only 22 active zones (table 51) on pieces from at the sites of El Castillo, Abri Olha I, Saint-Césaire, Chez-Pinaud and, to a lesser extent, Les Fieux (a single piece). At the first two sites, this mode of use was identified on 13 flake cleavers in ophite and quartzite, with the traces localized on the transverse distal edge (tables 58, 63, figures 228-229). The nine other tools, in flint, are of varying morphology: four unmodified flakes, two core-edge flakes and one with a cortical back, two denticulates, one Clactonian notch, a side scraper, and a *bec* (figures 229-230).

Macro use-wear, consisting of highly developed scarring (see Part II, chapter 2), has been linked to percussive activities in the exploitation of animal resources: expedient butchery (rapid deflesh-ing, forceful disarticulation) and/or, in the case of flake cleavers, the fracturing of bones (axial skeleton, long bones).

The scarring on flake cleavers, extensive and of large dimensions, stands in contrast to that observed on most of the other tools that were used in percussion. The intensity of the use-wear, combined with the probable hafting of the flake cleavers (see Part II, chapter 2) suggests that these pieces functioned differently from others that were probably not hafted.

On one hand, the flake cleavers would be employed, according to our experimental comparisons, to stages of forceful disarticulation (separating the skull from the vertebral column, for example) or fracturing (ribs, sternum, or long bones of even large ungulates). The edges that were used are heavily altered by scarring, and therefore difficult to describe. Nonetheless, the intact portions allow us to observe that the original active zones were convex in plan, rectilinear in profile, and biplanar in section. The average angle of these active edges is 54° ± 9°.

The other tools, probably held with the bare hand, present a lesser extent of alteration by use, likely related to their modes of use in disarticulation or defleshing. They could nonetheless have served to fracture the sternum of an animal of smaller size, such as a cervid. They systematically present a prehension zone adapted to the bare hand that is positioned opposite the active zone: a cortical and/or retouched back or even, in the case of a notched piece at Saint-Césaire, a back created by abrupt marginal retouch associated with a cortical surface. The active zones are unmodified, or modified into denticulates or side scrapers (Chez-Pinaud) or notched type. The side scraper from Chez-Pinaud bears shallow retouch on the active zone, which is convex in shape. In contrast, the unmodified (lateral left) edge on the side scraper from Saint-Césaire was the one used for butchery; alongside a core-edge back the semi-abrupt to abrupt retouch localised on the distal end forms a concave surface ideal of prehension. The active zones are of varied morphology in plan view (convex, rectilinear, denticulated, and, more rarely, concave, and pointed, see figures 228-230) and in profile (rectilinear, convex, concave) and are most often biplanar in section. The average angle of the cutting edge is 50° ± 7°.

The two pieces that bear traces of mixed modes of action and were probably used in butchery (a racloir from Chez-Pinaud and an unmodified flake in schist from Grotte du Noisetier, figures 229^{c}-230) could have been used for disarticulation and defleshing, by both percussion and cutting.

Unmodified or retouched tools that bear traces of percussion against a hard organic material and could have been used in butchery activities are rare in published studies (table 66). There are, however, some exceptions. One such example is from the Northern European site of Atilly "Bois de la Bocquillière", a double side scraper on a preferential-Levallois flake with partial retouch that bears scarring on its right edge (43°) indicative percussive contact with a hard material could have been used in forceful disarticulation. Similar traces have been observed on the retouched convex edge (46°) of a flake from Saint-Amand-les-Eaux, on which the opposing edge bears retouch by inverse, abrupt removals followed by crushing, forming a potential prehension zone. At Hermiès,

	Site	Tool types
Germany	Sesselfelsgrotte	notched pieces (possible use)
	Salzgitter Lebenstedt	*Faustkeile* ("bone breaking")
Northern France	Attilly "Bois de la Bocquillière"	double scraper with a partial retouch on a preferential Levallois flake
	Havrincourt "Les Bosquets" (sector 1)	preferential Levallois flake (used by cutting and maybe scraping) (possible use in percussion)
	Hermies "Le Tio Marché"	preferential Levallois flakes
	Saint-Amand-les-Eaux	retouched backed flake
North Center France	Le Fond des Blanchards	*hachoir* (large bifacial scraper)
South Western France	Bayonne Jupiter	biface(s) with a natural base and a distal transverse edge
	Chez-Pinaud (US 22)	Quina scrapers, scraper recycling flakes (traces on the platform)
	La Mouline	flake (possible use)
	Les Bessinaudes	biface(s) with a natural base and a distal transverse edge, unretouched semi-cortical flake
	Romentères	choppers (quartzite)
Spain	Badaran	flint flake cleaver (possible use)

Table 66 - Published data on Middle Palaeolithic assemblages in Western Europe that have yielded traces of percussion against a hard material, probably organic (butchery activity?) and the types of pieces that present such traces. See Annex 1 for the literature references.

L. Vallin *et al.* (2006) have interpreted the large removals on certain preferential-Levallois flakes as the result of percussive action on hard materials, in some cases as intermediate pieces for splitting bone. A reanalysis of some of these flakes (Claud *in* Goval, Hérisson [dir.], in prep.; Vallin [dir.], in prep.) showed that the proposed indirect percussion is unlikely, based in large part on the absence of evidence of percussive force on the end opposing the active zone. It seems more likely that these pieces were used in butchery activities, but in direct percussion on a carcass. This method of bone fracture or disarticulation can be inferred from extensive edge damage, while defleshing is more likely to produce less pronounced scarring. The two pieces bearing the clearest such traces have unmodified edges with an angle between 35° and 55° (measurements taken on either side of the damaged area). No trace of hafting was detected on these pieces but the presence, on the preferential-Levallois flakes, of abrupt retouch adjacent to the platform on one or both sides could be related to prehension of these tools, facilitating either use with the bare hand (in a limited manner) or hafting. The preservation state of the assemblages does not allow for a study of prehension. To conclude the examples in Northern Europe, the *Faustkeile* that could have been used to fracture bone at Salzgitter Lebenstedt (Germany, Let, 1988 *in* Steguweit, 2003), and the two notched pieces used in percussion at Sesselfelsgrotte could have been used on wood or bone, though the hardity of the materials worked is not mentioned (Rots, 2009: 45, fig. 9).

A bit farther south, the site of Fond des Blanchards (level D1) yielded a very large bifacial side scraper or *hachoir* with a convex cutting edge opposed to a thick end that served as a zone of prehension. It bears traces of percussion against a hard organic material of the osseous type (Coudenneau *in* Lhomme *et al.*, 2007). From the Quina level at Chez-Pinaud (US 22), several recycled flakes bear traces of percussion against a hard organic material, indicating that side scrapers, prior to being recycled, were used in this manner, probably for forceful disarticulation or defleshing (Claud *et al.*, 2012). Identical traces were observed on two side scrapers recycled by notches, which demonstrates that the scrapers were used in percussion just before and after recycling. The scrapers, unifacial or bifacial, bear scaled and/or stepped retouch or notches and possess edge angles between 44 and 62° (53° ± 9°). The complete pieces possess a thick cortical back opposite the active zone. In this level at Chez-Pinaud, reindeer is the predominant species (Niven *et al.*, 2012) as is likely the case of level D1 at Fond des Blanchards (Bemilli *in* Lhomme *et al.*, 2007).

Abri Olha I
(photographs: EC)
a - no. 2916, ophite
b - no. 1, quartzite
c - no. 2714, ophite
use: percussion against a hard organic material

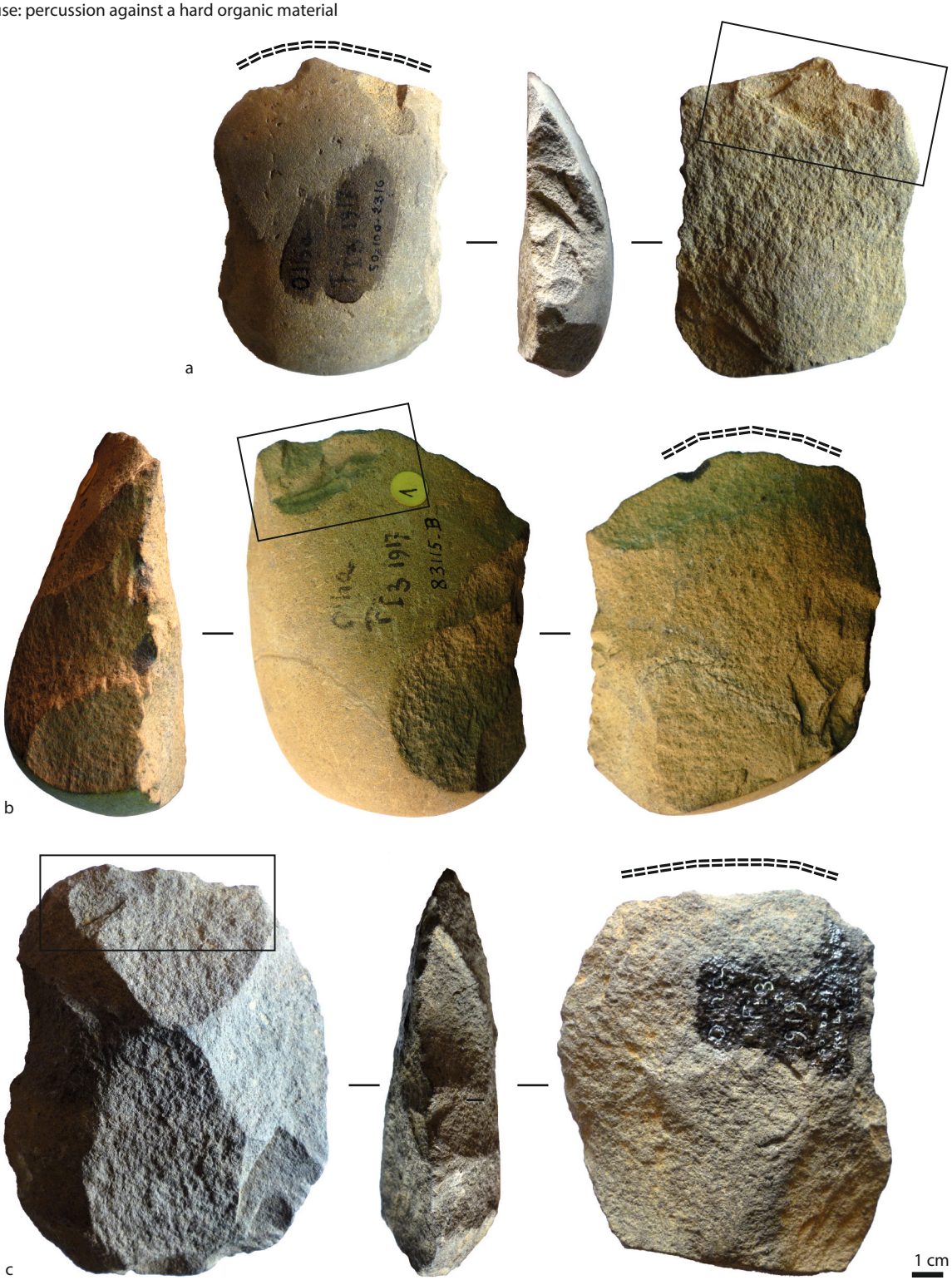
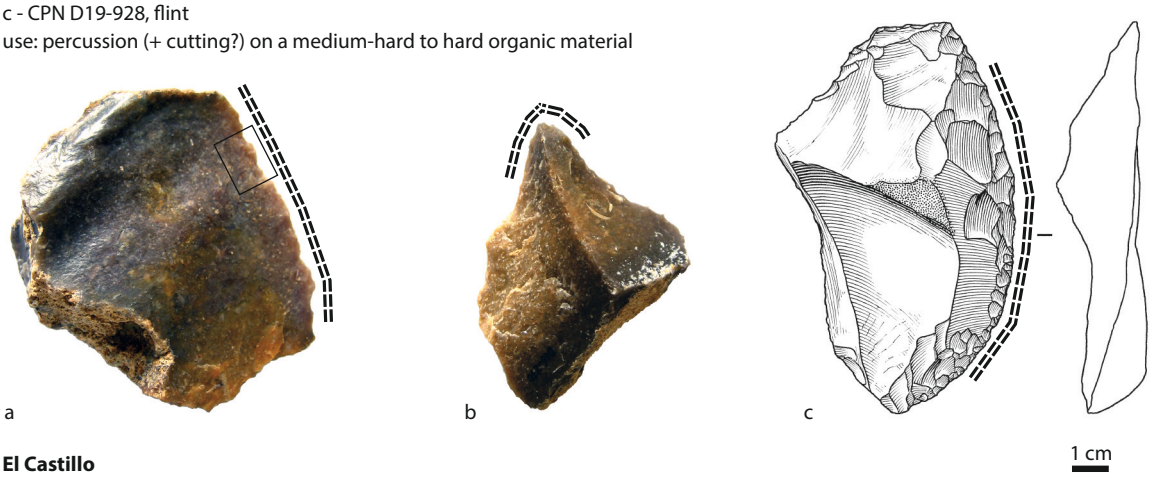


Figure 228 - Flake cleavers from the site of Abri Olha I bearing traces of percussion against hard organic materials, and probably used in the context of butchery. The black rectangles indicate the locations of the photographs of the use-wear traces presented in figure 176[a-c] (CAD: É. Claud and M. Coutureau).

Chez-Pinaud
(photographs: EC)
a - CPN E15 63, flint
b - CPN D16 270, flint
use: percussion against a hard organic material
c - CPN D19-928, flint
use: percussion (+ cutting?) on a medium-hard to hard organic material



El Castillo
(photographs: EC)
a - A 112, quartzite
b - A36, quartzite
use: percussion against a hard organic material

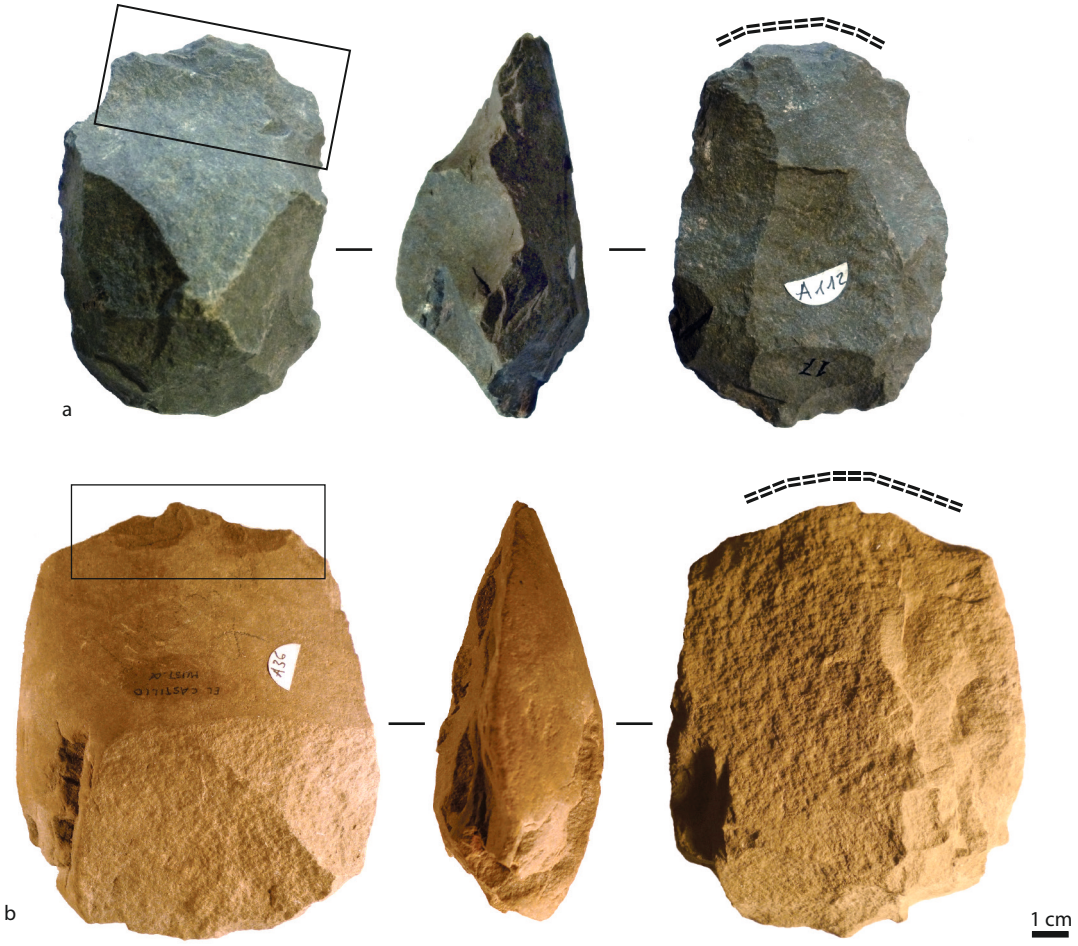
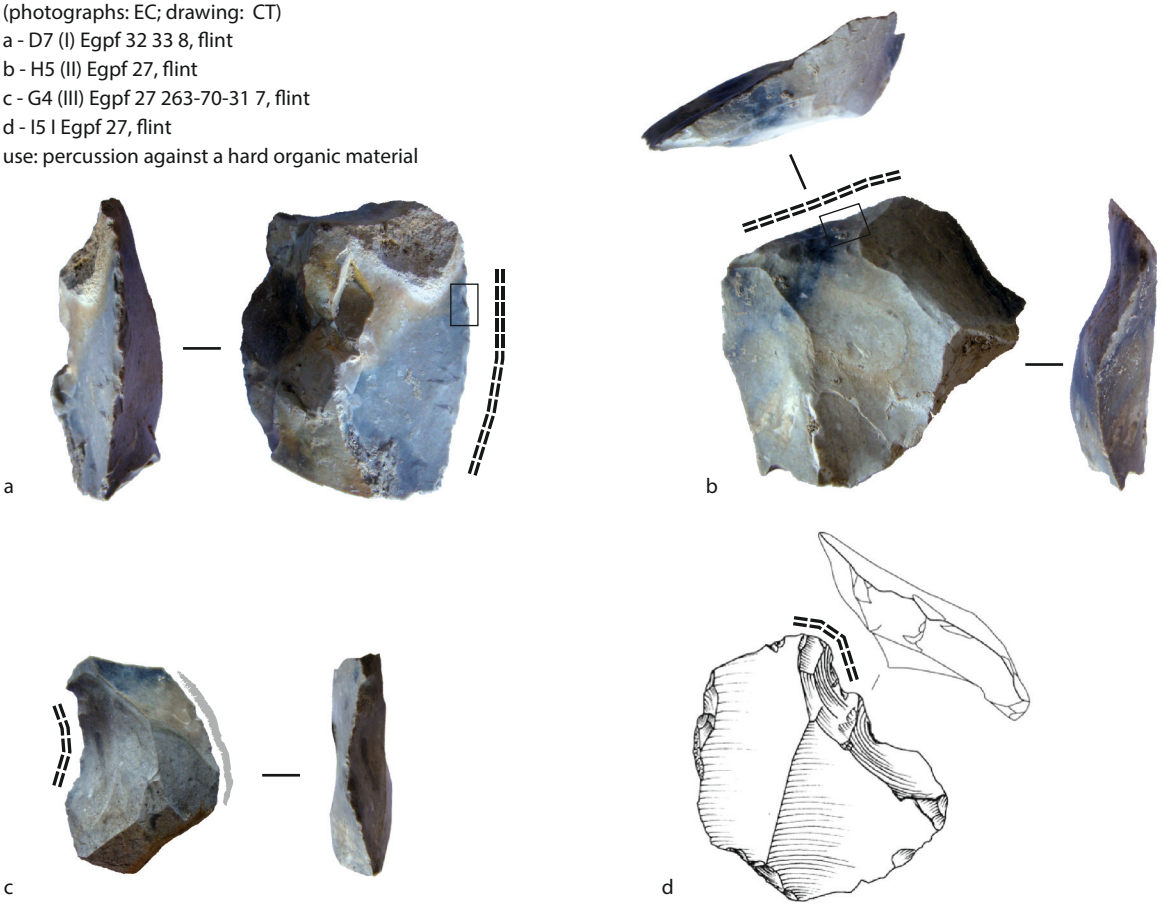
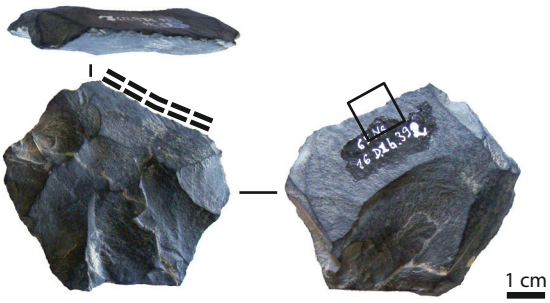


Figure 229 - Retouched tools from the site of Chez-Pinaud and flake cleavers from El Castillo bearing traces of percussion against hard animal materials and probably used in the context of butchery. The black rectangles indicate the locations of the photographs of the use-wear traces presented in figure 176[f-g] (CAD: É. Claud and M. Coutureau).

Saint-Césaire
(photographs: EC; drawing: CT)
a - D7 (I) Egpf 32 33 8, flint
b - H5 (II) Egpf 27, flint
c - G4 (III) Egpf 27 263-70-31 7, flint
d - I5 I Egpf 27, flint
use: percussion against a hard organic material



Grotte du Noisetier
(photographs: EC)
65NS 16 D 1b 292, schist
use: percussion against a hard organic material
(+ cutting?)



Les Fieux
(photograph: CT)
K30276, flint
use: percussion against a hard organic material

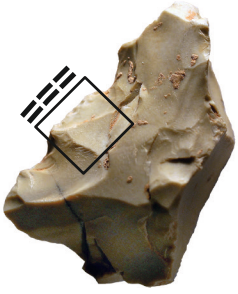


Figure 230 - Unmodified flakes and retouched tools from the sites of Saint-Césaire, Grotte du Noisetier and Les Fieux bearing traces of percussion against hard animal materials and probably used in the context of butchery. The black rectangles indicate the locations of the photographs of the use-wear traces presented in figure 177 (CAD: É. Claud and M. Coutureau).

A large flake from La Mouline bears, on its transverse convex distal edge, scars interpreted as the result of use in percussion against a medium-hard material, but the photograph provided shows that the traces are very similar to those obtained experimentally on edges used in percussion for disarticulation or defleshing of a carcass (Pasquini, 2008). It is therefore possible that this piece served in the latter activities rather than in percussion on wood. Some kilometres to the south, at Bessinaudes, two pieces bear traces compatible with use in percussive butchery: an unmodified semi-cortical flake with a low edge angle (26°), and a biface (perhaps two) with a natural base and a transverse distal edge with a cutting angle of 42° (Claud *in* Chadelle *et al.*, in prep.).

At the Middle Palaeolithic site of Romentères, choppers (n=11) were used in the percussion of medium-hard to hard or hard organic materials (Claud *in* Lelouvier *et al.*, 2012). On certain pieces, the numerous and large scars, could be the result of use in fracturing bones (sternum, ribs, for example). This hypothesis is further supported by the morphological characteristics of the pieces, namely their considerable weight (752 and 1037 g) and broad angles (75° and 67°).

At Bayonne Jupiter, in assemblage PM1, one or two flint bifaces with distal cutting-edges and natural bases could have served in percussion on a hard organic material (Cologne *et al.*, 2017b). The intensity of the use-wear traces corresponds either to disarticulation or defleshing.

Finally, at Badaran, P. Utrilla and C. Mazo (1996) note a possible flake cleaver in flint that bears polish from butchery and whose supposed mode of use was percussion.

Thus, the pieces that could have served in butchery by percussion are relatively rare in terms of the sites concerned and, if one excludes Romentères, infrequent in our study assemblages. Their typological diversity is considerable: flake cleavers, bifaces with transverse cutting edge, flakes, side scrapers – sometimes modified with notches – and choppers were used. Flint, ophite (flake cleavers) and quartzite (flake cleavers and choppers) were used (figure 239, table 70). The edges, unmodified or retouched, generally have a moderate angle (around 45°). The active angles of the modified cobbles at Romentères are the highest (67° ± 4°). All of the edges, with the exceptions of the flake cleavers, the preferential-Levallois flakes, and one flake from Bessinaudes, are positioned opposite a comfortable prehension zone that indicates potential use by hand. Hafting is supposed for the flake cleavers, and possible for the preferential-Levallois flakes, as the retouch adjacent to the platform seems insufficient preparation for bare-handed use. Due to reasons of imperfect preservation, potential traces of hafting could not be identified. Two functional groups could be identified amongst the pieces that were used in percussion: those used in forceful defleshing or disarticulation, held in the bare hand and presenting relatively light use-wear (flakes, denticulates, side scrapers, bifaces), and those pieces that were hafted (flake cleavers, perhaps certain preferential flakes) or held in the hand but rather heavy, apparently used in operations requiring greater force, such as fracturing.

The potential use of percussion in butchery activities could be influenced by several factors: the size of prey (percussion allowing for more rapid breakdown of large carcasses), specific nutritional requirements (intensive exploitation, with fracturing of the ribcage, for example), or even specific modes of carcass exploitation linked to the technological traditions of a group. Percussion with a sharp tool is not in fact necessary for disarticulating a carcass or fracturing a bone. It could even be considered less effective than percussion with a heavy, dull cobble in the latter case.

The archaeozoological data is difficult to apply to these questions because the axial skeleton is often underrepresented in Palaeolithic assemblages. Though no trace indicative of percussion has been found in the archaeofauna included in our study, the study sites that have yielded tools that bear traces of percussion also yielded faunal assemblages characterized by the presence of large ungulates (bison and horse). This suggests that the percussive tools could have been used in the segmentation of the axial skeleton. At the same time, the levels at Coudoulous 1, Mauran, and Les Fieux that are dominated by bison have not yielded tools of this type. At primary butchery sites,

it is entirely possible that the axial skeleton was abandoned once defleshed, without segmentation of the vertebral column; patterns in the faunal assemblages at residential sites support this scenario. Amongst the comparative sites that have yielded tools with traces of percussion, few have yielded faunal remains. Though the remains of large animals like horse and mammoth are numerous at Salzgitter Lebenstedt (Gaudzinksi, 1999a) and Sesselfelsgrotte (Rots, 2009), in contrast, US 22 at Chez-Pinaud (Niven *et al.*, 2012) and probably in level D1 at Fond des Blanchards (Bemilli *in* Lhomme *et al.*, 2007), reindeer is the dominant prey species. This suggests that prey size is not, itself, a determining factor. At Salzgitter Lebenstedt, the mammoth remains are primarily rib fragments that were used as tools (Gaudzinski, 1999b). One could speculate that there is a potential connection between the bifacial pieces used in butchery by percussion and the spiral fractures observed on these pieces that might result from the forceful separation of the ribs from the vertebral column (Gaudzinski, 1999b). Numerous traces of percussion observed on other mammoth remains (Gaudzinski, 1999b) could also derive from this mode of action. A detailed study of these traces of impact and fracture might provide some insights.

d - The scraping of bone

The active zones that bear traces of transverse contact with a hard organic material that could be bone (n=41) could be *a priori* related to different activities: removing remaining meat from bones (butchery), preparing the surface of bones for the extraction of marrow by fracturing (butchery), or to prepare a surface for use as a retoucher (fabrication of tools).

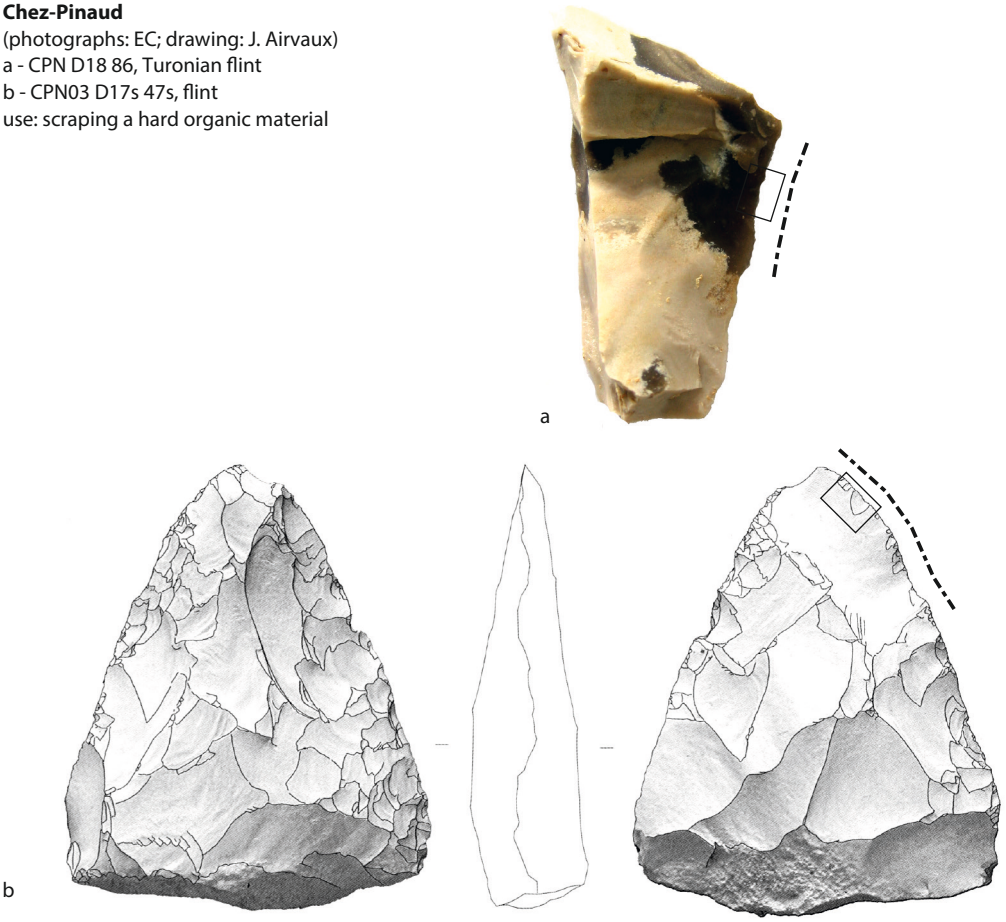
Scraping has been identified at Les Fieux, on 21 active zones – half of the active zones attributed to butchery activities at the site – at Mauran, on nine active zones, and at much less frequently at the sites of Chez-Pinaud (four zones), Saint-Césaire (three zones) and Coudoulous (three zones). At this last site, as noted above, 26 active zones show evidence of cutting and scraping of meat (see above) and of these, three show contact with bone.

The tools used in scraping a hard material like bone are made of flint, quartz, and quartzite (Les Fieux, Mauran, and Coudoulous), and are of varied types (table 58, figures 231-232). Unmodified flakes (one backed knife, one core-edge flake, and one pseudo-Levallois point), notched pieces (denticulates, Clactonian notches, one retouched notch) and side scrapers are the most numerous, but some retouched flakes and endscrapers, a biface manufacturing flake and a biface are also included. The morphology in plan view of the active zones is variable, but concave and rectilinear forms are frequent. The edge angles are equally varied, and in some cases (the retouched notch at Mauran, for example) the natural cutting edge of the piece has been modified by semi-abrupt or abrupt retouch. Nonetheless, most of the active zones, unmodified or modified with a shallow retouch (or a tranchet-blow in the case of the biface at Chez-Pinaud), probably presented a rather low cutting angle prior to use. The initial edge angles, though, are difficult to quantify because they have been clearly modified by edge damage, rendering the edge more abrupt.

Seven pieces, from Bayonne le Prissé PM2 (scraper), Chez-Pinaud (unmodified flake), Mauran (unmodified flake, backed core-edge flake, pseudo-Levallois point), Saint-Césaire (unmodified semi-cortical flake, backed core-edge flake) could also be included in this category, as they were used to scrape a medium-hard to hard material that could have been very hard wood or bone (figures 233-234).

With the exception of Fonseigner, the faunal assemblages at the sites concerned allow for some further discussion of the activities that generated the use-wear observed. Amongst the four assemblages, only Les Fieux yielded a fragment of equine (*E. hydruntinus*) tibia that had been scraped, but the poor preservation of the osseous surfaces could introduce certain bias to the study. Aside from Coudoulous 1, none of the sites produced a bone retoucher. If we accept that these pieces

Chez-Pinaud
(photographs: EC; drawing: J. Airvaux)
a - CPN D18 86, Turonian flint
b - CPN03 D17s 47s, flint
use: scraping a hard organic material



Les Fieux
(photographs: CT)
a - K 30808, quartzite (denticulate)
b - K 19 VI 35562, quartzite (denticulate)
c - K 32011, flint (pseudo-Levallois point)
d - K 30228, quartzite (notched piece)
e - K 34280, flint (denticulate)
use: scraping a hard material

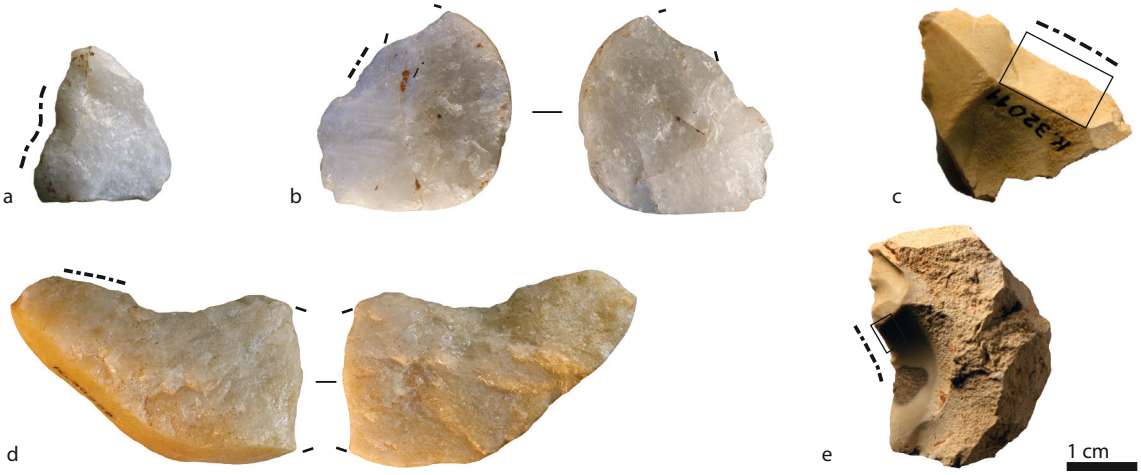
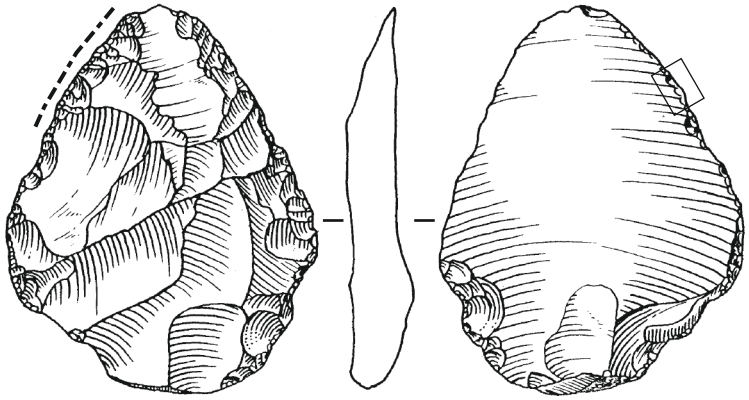


Figure 231 - Unmodified flakes, biface and retouched tools from the sites of Chez-Pinaud and Les Fieux bearing traces from scraping an organic hard material of bony type. The black rectangles indicate the locations of the photographs of the use-wear traces presented in figures 178[b,e] and 179[c] (CAD: É. Claud and M. Coutureau).

Fonseigner
(drawings: J.-M. Geneste)
Fons 77.Z3.Dsup.03 28, flint
use: scraping of a hard organic material



Mauran
(photographs: CT)
1 - M75 II E13 29, flint (notched piece)
2 - M77 E12 83, flint (side scraper)
3 - M781 2007, flint (notched piece)
use: scraping a hard material
4 - M74 II H12 134, quartzite
use: scraping a medium-hard to hard material

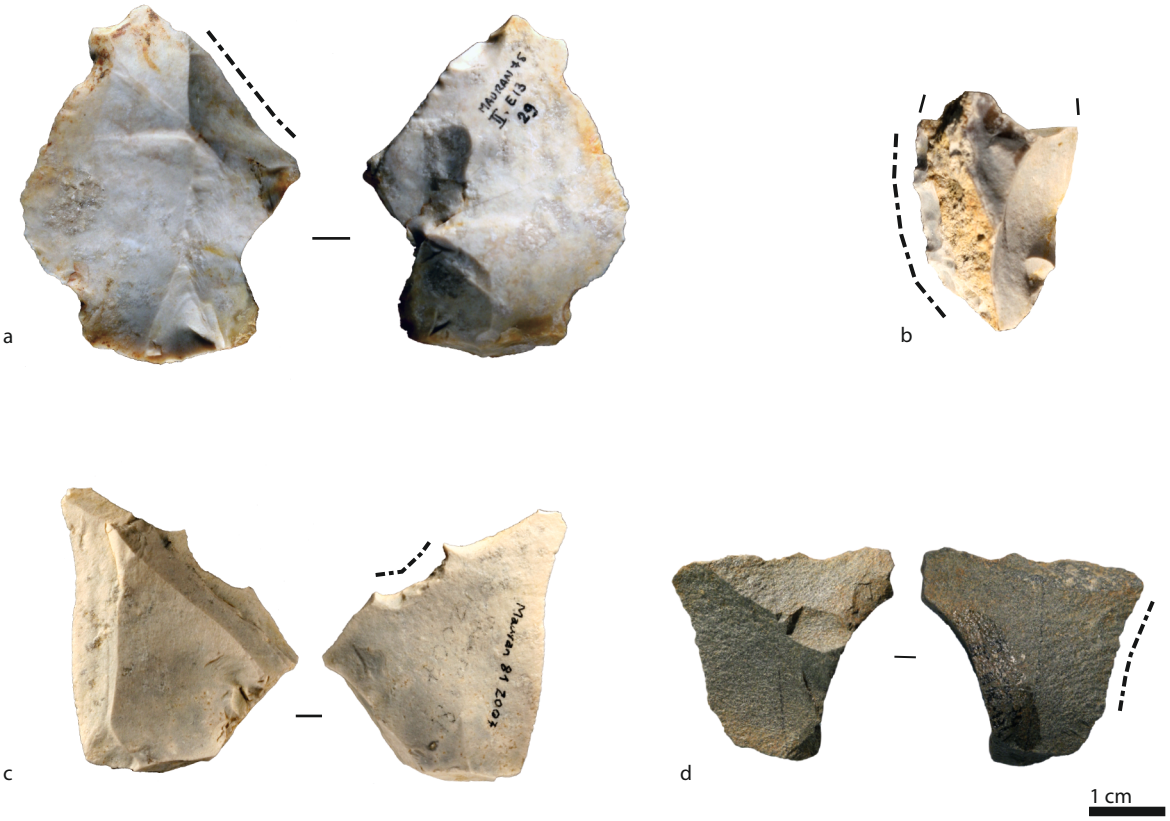


Figure 232 - Unmodified flakes and retouched tools from the sites of Fonseigner bearing traces from scraping an organic hard material of bony type. The black rectangle indicates the location of the photograph of the use-wear traces presented in figure 178[f] (CAD: É. Claud and M. Coutureau).

Bayonne le Prissé
(photographs: EC)
PM2 30010, flint
use: scraping of a medium-hard to hard organic material

Grotte du Noisetier
(photographs: EC)
a - NS07 D12 c1 208, quartzite
b - 65NS 18 D 1 79, schist
c - NS65 D17 c1 160, quartzite
use: possible scraping of a medium-hard to hard material

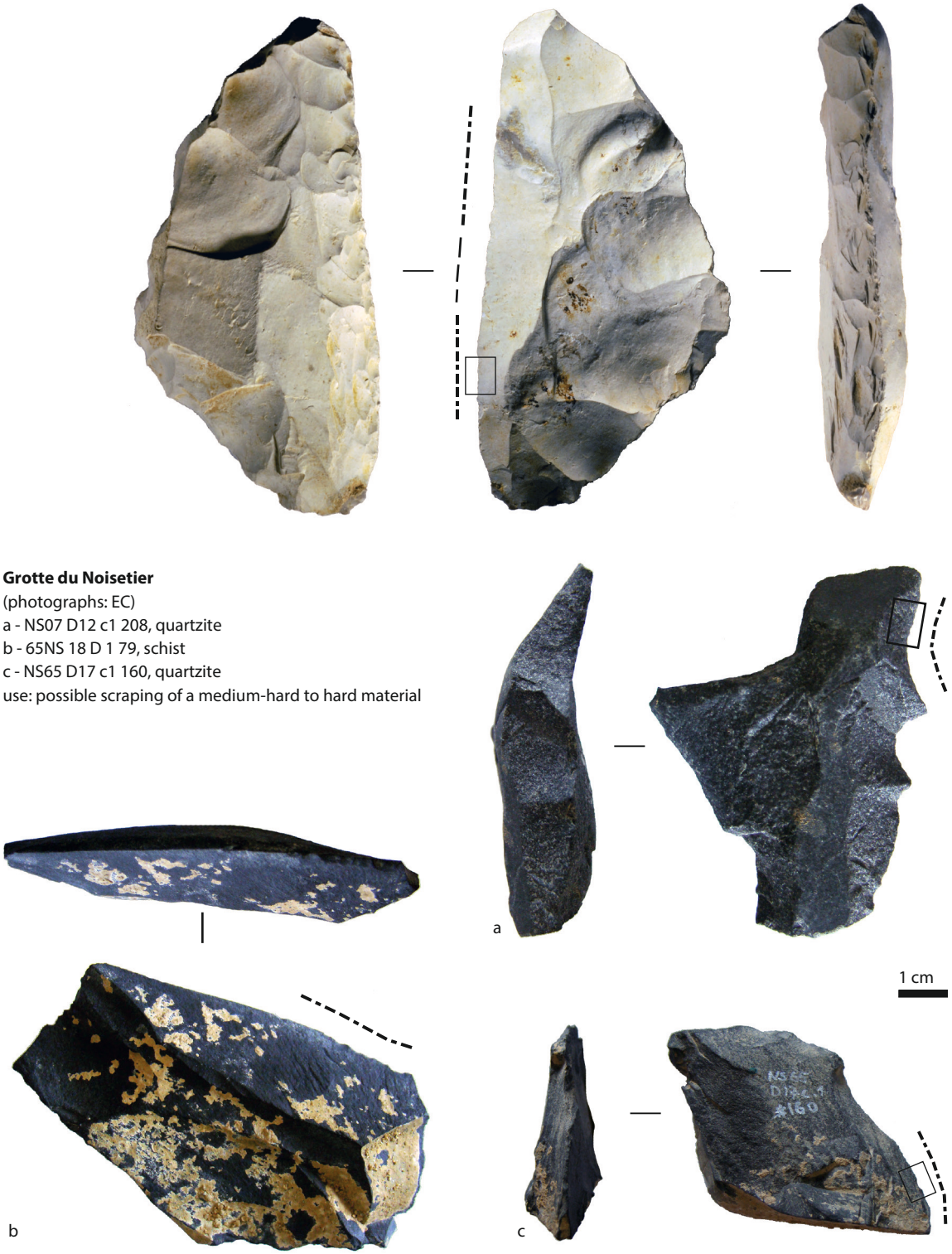
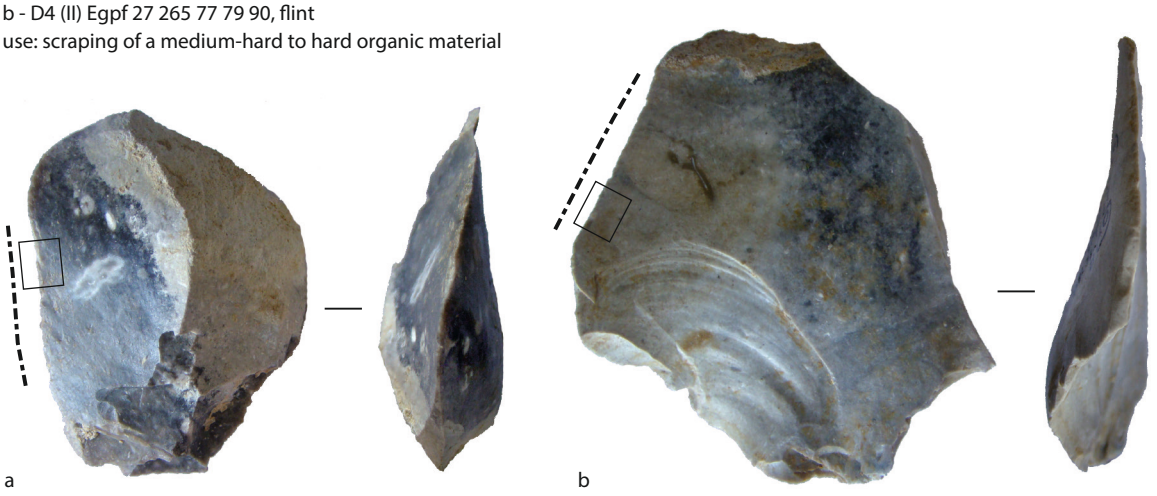


Figure 233 - Unmodified flakes and retouched tools from the sites of Bayonne le Prissé (PM2) and Grotte du Noisetier bearing traces of scraping hard or medium-hard materials that could be related to butchery activities. The functional (rather than natural) origin of these traces at Grotte du Noisetier, and at Bayonne Le Prissé, the precise activity (butchery, working of hardwood?) could not be determined with certainty. The black rectangles indicate the locations of the photographs of the use-wear traces presented in figures 178[a] and 179[a-b] (CAD: É. Claud and M. Coutureau).

Saint-Césaire
(photographs: EC)
a - H6 (IV) Egpf 29, flint
b - D4 (II) Egpf 27 265 77 79 90, flint
use: scraping of a medium-hard to hard organic material



Chez-Pinaud
(photograph: EC)
CPN D19 1422, flint
use: scraping of a medium-hard to hard organic material

Figure 234 - Unmodified flakes from the sites of Saint-Césaire and Chez-Pinaud bearing traces from scraping hard or medium-hard materials that could be related to butchery activities. The activity (butchery? working of hardwood?) could not be determined with certainty. The black rectangles indicate the locations of the photographs of the use-wear traces presented in figures 178[c] and 179[e-f] (CAD: É. Claud and M. Coutureau).

were used in scraping bone, scraping activities at the other sites (Mauran, Les Fieux, Saint-Césaire, Chez-Pinaud) could have been related to butchery. In this case, scraping could have served two functions: the extraction of slivers of meat still attached to bone, or the preparation of bone surfaces for the recuperation of marrow by fracturing. The latter practice, experimentally conducted on bovine tibia and femur under the auspices of the PCR, show that preparation by removal of the periosteum allows for better propagation of the waves of percussion that fracture the bones. According to these experiments, scraping is not necessary for the fracturing of the femur, but is essential for the fracturing of the tibia (Gerbe *et al. in* Thiébaut *et al.*, 2008). At Mauran and Les Fieux, given the quantity of meat recovered and the number of fractured long bones, it is probably that the scraping of bones was undertaken as a phase of marrow exploitation from long bones. Without observable traces on the bones, it is not possible to exclude the scraping of other materials, such as very hard or heat-treated wood, for the fabrication or maintenance of spears, for example (see above). At Grotte du Noisetier, the surface of a retoucher shows traces of scraping, indicating surface preparation prior to use as a retoucher. At this site, dubious use-wear traces of scraping observed on certain lithic pieces (not counted in the 41 active zones tallied, but nonetheless illustrated in part in figure 233[a-c]) could be linked to this sort of activity. Similarly, at Les Pradelles, traces of bone-scraping in the preparation of the surfaces of certain retouchers have been identified (Costamagno *et al.*, 2017) and prove that scraping is not strictly limited to butchery activities.

Amongst the published use-wear analyses, scraping on a hard organic material has been identified in a relatively limited number of assemblages (n=30, table 67) and, with the exception of Grotta Breuil, on a limited number of artefacts (generally fewer than five per site). Some assemblages have yielded tools that were used to scrape a medium-hard to hard organic material, and the possibility that material was wood cannot be excluded. The relevant objects are rarely described in detail, but the use of unmodified edges is frequently mentioned, whether on ordinary flakes (Havrincourt sector 2, La Combette, Abric Romaní, Grotta Breuil, El Salt), core-edge flakes (Corbehem), recycling flakes (Chez-Pinaud US 22), pseudo-Levallois points (Beauvais), Levallois point (Abric Romaní level 0), bladelets (Champ-Grand) or flakes produced by secondary debitage (Le Pucheuil). Retouched tools, comparatively rare, include side scrapers, some used on the retouched edge (Combe-Grenal, Fumane, Grotta Breuil, Ciota Ciara Cave, El Esquilleu) and others used on the unretouched edge (Saint-Amand-les-Eaux, Chez-Pinaud US 22), denticulates (Abric Romaní), and *limaces* (Champ-Grand). At Grotta Breuil, the tools that functioned in scraping for butchery purposes have been interpreted as defleshing tools, with the exception of two pieces from layer 6 that show polish characteristic of scaling fish. At the site of El Salt, the cortical flake mentioned could have served to scrape meat from a bone.

Amongst these studies, few examples provide evidence, notably on the fauna, that could be used to evaluate the interpretation of the lithic analyses. At ten of the sites no faunal assemblages were preserved, and at three of them the surfaces of the bones were poorly preserved (Havrincourt, sectors 1 and 2; Le Fond des Blanchards). At other sites, either no archaeozoological study has been published (Spy, Semal *et al.*, 2009), Combe-Grenal (Guadelli, 1987), Abri du Musée (Bourguignon, 1992), or the published studies are not detailed (El Esquilleu, Yravedra *et al.*, 2014; Sesselfesgrotte Rots, 2014; Santa Croce, Boscato, Crezzini, 2006). At two sites (La Combette, Texier *et al.*, 2003; Ciota Ciara, Buccheri *et al.*, 2016), no traces were identified on the bone surfaces. At Grotta Breuil, the presence of scraping traces in layer 3 indicates the removal of scraps of flesh, potentially indicative of dietary stress (Alhaique, Lemorini, 1996). In level 6, rare traces of scraping were also observed. For the assemblage from US 22 at Chez-Pinaud, the tools presenting traces of scraping on bone could have resulted from butchery, or from surface preparation for use as retouchers, as indicated by the traces of scraping observed on retouchers from this layer (Mallye *et al. in* Jaubert *et al.*, 2008). Some pieces from Sesslfelsgrotte, whose techno-typological characteristics are not described, served in scraping a hard material like bone or antler. They were not directly involved in butchery activities, but in the transformation of animal materials, as tools for the perforation of hard materials have also been identified (Rots, 2009). At Fumane, the traces of scraping described could be related to the removal of periosteum before the fracturing of bones (Romandini *et al.*, 2014a). Nonetheless, because of the presence of retouchers in the Quina level, it is difficult to determine the precise nature of the activities that left use-wear traces associated with scraping. Some pieces with such traces are also noted at El Salt (levels 4e and 4.1) but in figure 7e (*in* Machado, Perez, 2016), the cutmarkss identified as scraping marks on a rib appear more similar to cutmarks from cutting than scraping. Finally, at Abric Romaní, bones bearing this sort of trace are indicated in layers H, Ja, M, and O (Cáceres, 2002; Fernándex Laso, 2010; Gabucio *et al.*, 2014a).

On the basis of the available data, scraping could have served in a variety of butchery activities (meat extraction or bone preparation for fracturing) as well as the preparation of osseous materials for utilitarian purposes (retouchers), and it is difficult to distinguish between them. With the exception of certain assemblages (Mauran, Les Fieux, Grotta Breuil), these traces are not widely distributed. The tools are of variable morphology, but appear preferentially on unmodified blanks, notched pieces, and side scrapers (figure 239, table 70). Levallois points, Mousterian points, and bifaces are rare or even absent from this functional group.

	Site	Scraping hard material	Sacraping bone / meat on bone (micro-polishes)	Tool types
Belgium	Spy	**x?**		Mousterian point
Germany	Neumark-Nord	**x?**		unretouched flakes
	Sesselfelsgrotte	**x**		undetermined
North France	Beauvais "La Justice"	**x**		pseudo-Levallois points
	Corbehem		**x**	core edge flakes from Levallois debitage
	Havrincourt "Les Bosquets" (sector 2)	**x?**		unretouched flake
	Havrincourt "Les Bosquets" (sector 1)	**x**		preferential Levallois flake (used by cutting and maybe by percussion, and possibly by scraping too)
	Le Pucheuil		**x**	"Le Pucheuil" flakes
	Rémicourt	**x?**		undetermined
	Saint-Amand-les-Eaux	**x**		retouched flake (retouches on lower face)
North Center France	Le Fond des Blanchards	**x?**		scrapers
South West France	Cantalouette II	**x**		undetermined
	Combe-Grenal (layers 21-24)		**x**	Quina scraper
	Chez-Pinaud (US 22)	**x**		unmodified flakes, including a scraper recycling flake and a retouched flake (traces on the unretouched edge)
	Abri du Musée	**x**		undetermined
	Les Bessinaudes	**x?**		unretouched flake, scraper (traces on the unretouched edge)
South East France	Champ-Grand	**x**		*limaces*, bladelets
	La Combette		**x**	unmodified flake + undetermined
Italy	Grotta Breuil (layer 3)		**x**	flakes (with biplanar or plano-convex section and straight or concave profile)
	Grotta Breuil (layer 6)		**x**	flakes + others? (with rectilinear and convex delineation)
	Grotta Breuil (layer XX)		**x**	mainly scrapers and flakes with concave profile
	Fumane	**x**		Quina scrapers
	Ciota Ciara cave	**x**		quartz scraper
	Santa Croce	**x?**		retouched flakes?
Iberian Peninsula	Abric Romaní (levels H, I, Ja)		**x**	unretouched flakes, denticulates
	Abric Romaní (level 0)	**x**		Levallois point
	Abric Romaní (level M)		**x**	unretouched flake
	El Esquilleu		**x**	Quina scraper
	El Salt		**x**	cortical flake
	Ribeira Ponte da Pedra / Atalaia	**x?**		flakes

Table 67 - Published data on Middle Palaeolithic assemblages in Western Europe that have yielded traces related to scraping bone, meat, and a hard to semi-hard material (butchery activity?) and the types of pieces that present such traces. The cross with a question mark indicates that the pieces were used to scrape a semi-hard to hard material, from which wood cannot be excluded, and interpretations must be cautious. See Annex 1 for the literature references.

e - Butchery activities as revealed by faunal analysis

Given the sheer abundance of available archaeozoological studies, it was not possible to complete an exhaustive synthesis of evidence for butchery of the kind that was completed with regard to use-wear studies of lithic assemblages. In addition to the systematic study of the literature on the sites included in the use-wear studies (see above), we have chosen to focus in this chapter on studies that provide detailed information on the placement and orientation of cutmarks, with emphasis on activities that are relatively underrepresented in the literature, such as skinning and the removal of tendons. Only evidence relevant to large mammals were retained: layers 4 and 9 from Roc de Marsal (Hodgkins, 2012; Castel *et al.*, 2017), Pech de l'Azé IV (Hodgkins, 2012), Abri du Maras, Baume Flandin, Balazuc, layers Fa and Fc-d at Payre, layers g and h at Saint-Marcel, Baume des Peyrards (Daujeard, 2008), Biache-Saint-Vaast (Auguste, 1995), the Discoid Mousterian level and levels A5/A6 at Fumane (Peresani *et al.*, 2011b; Romandini *et al.*, 2014a) and Ciota Ciara (Buccheri *et al.*, 2016).

At Mousterian sites subjected to archaeozoological analysis, the systematic observation of cutmarks from defleshing and traces of percussion related to the exploitation of marrow indicates the importance of meat and fat to Neanderthal groups. At some sites, the underrepresentation of the epiphyseal ends of long bones has been interpreted as evidence for the exploitation of the grease contained in spongious tissue for purposes that may have been dietary, technological, or combustible (Boscato, Crimini, 2006; Costamagno, 2013; Costamagno, Rigaud, 2014; Yravedra *et al.*, 2014; Castel *et al.*, 2017).

With regard to the disarticulation of carcasses, the underrepresentation of epiphyses at a number of sites has limited the reconstruction of operational sequences. Such is the case at Les Pradelles and Grotte du Noisetier. At Roc de Marsal, no trace of disarticulation has been documented in the assemblages 4 and 9 due to the near total absence of epiphyseal extremities. At Biache-Saint-Vaast, cutmarks present on the femoral head (*Fp-a*) and distal condyles (*Fd-d*, *Fd-g'*) provide solid evidence for the dismemberment of the hindquarters and disarticulation of the knee. At the sites studied by C. Daujeard (2008), several cutmarks also indicate this phase of butchery. The cutmarks illustrated are primarily located on the lower bones of the foot. The disarticulation of the ankle is evidenced at Payre on horse bones in layer Fc-d (*Gcf-a*, photo 115 *in* Daujeard, 2008), on bovid bones (*Tal-c*, *Tal-c'*, photo 112, idem) and red deer bones (*Cbn-a*, photo 115, idem) in layer Fa, at La Baume des Peyrards on red deer bones (*Tal-d*, photo 97, idem) and, potentially, on roe deer bones in layer g at Saint-Marcel and ibex bones at Balazuc (*cal-a*, photos 108-118, idem). The traces present on the external malleoli of two ibex tibia, not documented in our study samples, also attest to the disarticulation of the ankle. Finally, the different types of cutmarks identified on the distal extremity of a red deer humerus from layer Fa at Payre indicate the disarticulation of the elbow (*Hd-d*, *Hd-d'*, *Hd-e*, photo 109, idem). In contrast, the cutmarks observed on the neck of an ibex scapula from la Baume de Peyrards and interpreted as the result of disarticulation (Daujeard, 2008) are in fact related to defleshing (*Sc-b*, photo 96, idem), as are the cutmarks observed on the proximal end of a red deer radius from Balazuc (*Rp-f*, photo 116, idem).

Traces of skinning are noted at numerous sites on both ungulates and carnivores. This skinning is most often accompanied by defleshing, even in the case of carnivores: for example, at Biache-Saint-Vaast, Hohle Fels, Ciota Ciara, the Discoid level at Fumane, level M at Abric Romaní (Auguste, 1995; Münzel, Conard, 2002; Romandini *et al.*, 2014a; Gabucio *et al.*, 2014a; Buccheri *et al.*, 2016). On the ungulates and at the sites included in our synthesis, some traces present on fragments of mandible (*Man-c*) indicate skinning of the head: Baume Flandin (photo 119, idem) and Abri du Maras (photo 120, idem), Fumane (red deer and roe deer), Roc de Marsal 9 and 12, Pech de l'Azé IV I2 and YZ (figure B7, *in* Hodgkins, 2012). Regarding the lower legs and feet, the three types of cutmark described in our study sample are present at the sites included in our broader discussion. Circular

incisions are documented at Baume des Peyrards on the distal diaphysis of a horse metapodial (*Mts-c˝* or *Msc-c˝*, photo 99, idem) and a second phalanx of an ibex (photo 102, idem). At Fumane, this type of cutmark is visible on the middle shaft of a red deer metacarpal (*Mcs-b˝*), the first phalanx of a red deer (*Phl-a*) and the distal metatarsal of a roe deer (*Mts-b˝*). At Roc de Marsal and at Pech de l'Azé, no such cutmark is noted, even though traces related to the removal of skin are numerous (*Mcs-a*: Roc de Marsal 4, *Mcs-b*: Roc de Marsal 4 and 9, Pech IV YZ, *Mts-a*: Roc de Marsal 4 and 9, Pech IV 12 and YZ, *Mts-b*: Roc de Marsal 4, *Td-c*, *Td-a˝*: Roc de Marsal 4). They co-occur with cutmarks related to the longitudinal incision of the hide. Aside from longitudinal cutmarks observed on a distal shaft-fragment of a tibia from layer 4 of Roc de Marsal (*Td-a'*), they are also present on the lateral surfaces of metapodials (*Mcs-b´* and *Mts-b´*: Roc de Marsal 4). These two sites, for which documentation is complete, allow us to postulate certain modes for the cutting and removal of skins. At both sites, the absence of circular incisions on the metapodials and phalanges could indicate that the starting incisions were made closer to the hooves. The fact that longitudinal cutmarks are present on the lateral faces of these elements in layer 4 at Roc de Marsal and absent in the other three layers – which could indicate that incisions were made on the posterior[4] or anterior surfaces – suggests that the skinning of the trunk and the legs were distinct operations, in keeping with starting the incisions closer to the hoof. A re-examination of the faunal assemblage would be necessary to confirm this hypothesis, but it is worth noting that at Les Pradelles and Roc du Marsal, which share many features (Quina Mousterian, intense specialisation on reindeer, intensive exploitation of resources down to the grease in the spongious tissue), skinning traces document different methods: skin from the feet taken at Roc de Marsal, little attention to this part of the hide at Les Pradelles (see above). The factors underlying these disparities (different groups, different seasons of occupation, the intended use of the hides) are difficult to determine based on the evidence at hand, but this example underscores the importance of the detailed study of butchery cutmarks. Paired with use-wear analyses of lithic tools, such approaches could shed new light on the behaviour of Neanderthal groups.

Cutmarks associated with the extraction of tendons are often interpreted as skinning cutmarks due to the lack of experimental references for the former activity. They are present in layer g at Grotte Saint-Marcel on a red deer metacarpal (*Mcs-c*, photo 103 *in* Daujeard, 2008)). At Fumane in level 9, the cutmarks depicted in figure 7d (*in* Romandini *et al.*, 2014a) and interpreted as cutmarks from skinning are clearly the result of tendon removal on the anterior surface of a red deer metatarsal (*Mts-c*). In levels A5/A6, the removal of the posterior tendon is attested on at least one red deer metatarsal (*Mts-f*) and of the anterior tendon of a roe deer (*Mcs-c*). At Roc de Marsal layer 4, on the metacarpals, only the removal of posterior tendons (*Mcs-f*, *Mcs-f˝*) is attested (longitudinal or transverse gestures) while on the metatarsals, it is exclusively the anterior tendons (*Mts-c*, *Mts-c'*). In layer 9, not a single cutmark indicates this activity. At Pech de l'Azé IV, it is the anterior tendons of the metacarpals (*Mcp-b˝*, *Mcs-c*) and the posterior tendons of the metatarsals (*Mts-f*, *Mts-f'*) that were removed. Without a precise count of the anatomical zones identified in different sites, it is difficult to infer a preference for any particular tendon, but this type of analysis once more offers new perspectives on the practices of Neanderthals related to the use of certain tendons. These preferences could have been dictated by their intended use (as bindings, glue, or a food-source) or by the time allotted to processing. In the case of immediate needs for bindings, the anterior tendons of the metacarpal, which are thinner and dry more quickly, may have been preferred. At this time, traces related to the removal of tendons are exclusively documented on cervid bones. The question of species preference related to the intrinsic characteristics of tendons (length, strength, ...) remains to be examined.

4. Longitudinal striations (*Mts-c'*) present on either side of the malleolar groove and not inside it could evidence this gesture rather than the removal of tendons.

f - Hide working

Thirty-four active zones, only 7 % of the identified active zones, served to cut (21 zones), scrape (10 zones), and, to a lesser extent, perforate (2 zones) skins (tables 51, 68, figure 211). One piece served in both cutting and scraping (Fonseigner).

Cutting was identified at Chez-Pinaud (14 active zones), Fonseigner (7) and Coudoulous (1); scraping at Fonseigner (7), Coudoulous (2), Grotte du Noisettier (1) and Mauran (1), while perforation is probable (absence of micro-polish) at Les Fieux (1) and at Mauran (1).

Even if the exact state of the hide is difficult to determine with precision and certainty (see Part II, chapter 2.2.C), it seems that hides in different states are represented: dry hide at Grotte du Noisetier, dry and semi-dry hide at Coudoulous and fresh or moist hide and dry hide at Fonseigner. Tools in flint, quartz, and quartzite were used.

In these assemblages, the number of tools that were used to work hide is low (2 to 8 %, table 68), with the exception of Fonseigner. At this site, the activity is actually well represented, with 13 active zones of 46, or a frequency of 28 %. The state of the cut hides is intermediate, which is to say they were moist and supple. This state and the mode of action could correspond to the hide-defleshing phase, or to the cutting of hide already prepared to be used in the manufacture of objects, such as thongs, clothing, or sacs. Nonetheless, it is easier to achieve a neat and precise cut on a completely dry hide than on a hide that is still fresh, and it is therefore more probable that the cutting of moist hide corresponds to a phase of cleaning. The general morphology of the tools that bear traces of hide-cutting also point to this phase of processing, as the active zones are convex in plan (rectilinear in one case) and rectilinear in profile, with no irregularities on the edge that could accidentally puncture the skin during the cleaning process (figure 237). The cutting angles are low to moderate (31° to 51°). The active zones are localised on four side scrapers (amongst which one, elongated, was used on its unmodified edge) and a Mousterian point. The use of the latter for the defleshing of hide would nonetheless be surprising given the convergent morphology of the active zone and the presence of traces that could indicate hafting on the proximal end. If this piece was truly hafted in a distal fashion, its use in hide-defleshing is improbable because the handle would be more of an impediment than an aid given that the required gesture is very tangential and requires a controlled pressure that is distributed over a wider cutting edge (and not a pointed zone that risks puncturing the hide). It is therefore possible that this piece was used in some other phase of hide working, for example the initial incision of the hide or skinning; contact with bone is not indicated. One of the side scrapers appears to have been resharpened (reduced blank with semi-abrupt retouch).

	Number of active zones with cutting traces	Number of active zones with scraping traces	Number of active zones with piercing traces	Number of active zones with cutting and scraping traces	Total number of active zones	Frequency of hide working (%)
Chez-Pinaud (US 06/07)	14				170	**8**
Coudoulous (layer 4)	1	2			64	**5**
Fonseigner (D sup)	6	6		1	46	**28**
Grotte du Noisetier		1			21	**5**
Les Fieux (layer K)			1		52	**2**
Mauran		1	1		57	**4**
Total	**21**	**10**	**2**	**1**	**492**	

Table 68 - Number of active zones interpreted as having been used in hide-working activities and the frequency of this activity according to the assemblages studied.

Scraping tools present traces that are more compatible with the working of dry hide. They could have served to finish the defleshing of dry hides, or to another phase of hide working that required sharp edges such as thinning. Indeed the active edges, with the exception of one active zone retouched into a scraper that also could have served to slice, are unmodified, convex in plan and in profile and with a fairly low cutting-edge angle (38° to 57°). For the most part, these tools are unmodified flakes or tools on which the unmodified edge was used to scrape dry hide (figure 237). The retouched edges of side scrapers were, in one case, used in butchery. On the other tools, these edges were less regular and the cutting-edge angle was higher than on those of the side scrapers that were used in butchery or cutting hide. This could suggest that side scrapers that were already used and were no longer functional, or on which the retouch was unsatisfactory, were used to scrape hides, unless the retouch was intended to provide a zone of prehension. Yet, in this latter case it would have been more simple and effective to perform an abrupt, marginal retouch of the backing type. It is possible that an abrasive was present on the surface of the hide. It could have been applied in advance of scraping to aid in the drying process and keep the hide from rotting, or added during scraping for its abrasive and colouring qualities.

In the assemblage from US 06/07 at Chez-Pinaud, 14 active zones served to work hide by cutting, in a fresh to intermediate state. As at Fonseigner, the polish is compatible with the incision of the hide at the start of the skinning process but without contact with the bone, the cutting of the hide once removed (cutting in contour, creation of holes) or in hide-defleshing. Three of these tools, bifaces, could have served in skinning, based on their morphology (the presence of a point) and, in one case the presence of another active zone indicates that it could have also served in butchery (figures 235-236). As for the 11 other active zones, aside from presenting no scarring characteristic of butchery, their morphology is absolutely compatible with the hide-defleshing: the edges are often convex in plan and rectilinear in profile and the cutting-edge angles are between 30° and 45°. They are unmodified flakes and side scrapers, with the addition of an exhausted biface. Two of the side scrapers were clearly resharpened, with the retouch interrupting the use-wear, reduced to a small zone spared by the new retouch (figure 235[e-f]). No biface manufacturing flakes bear traces related to hide working.

At the other sites, the anecdotal presence of pieces that bear traces of hide working prevents us from drawing conclusions about patterns, in terms of the activities performed and the tools employed. One can nonetheless highlight the presence, at Coudoulous, of a side scraper that was used to cut dry hide and a side scraper that was used to scrape hide in an intermediate state (figure 238). At Grotte du Noisettier, where an unmodified flake in quartzite bearing traces of scraping dry hide was also identified, it is possible that problems of preservation have led to an underestimation of the hide working activities, notably by cutting, and especially in the case of brief use. Finally, the identification of traces of perforation of hide on two pseudo-Levallois points at Mauran and Les Fieux is notable (figure 236). They could correspond to the creation of holes for fixing hides for preparation or for the confection of objects in leather. It is surprising that the tools used in hide working at these sites are limited, or nearly (at Mauran, a core-edge flake bears traces of scraping on hide) to tools of perforation, with no piece having served in cutting. Once again, the state of preservation of these assemblages is imperfect, and could be the basis of this absence.

Furthermore, it must be kept in mind that the absence or rarity of tools used in hide-working activities does not necessarily exclude this activity at a site, as the working of hides does not absolutely require the use of retouched lithic tools (Adams, 1988; Plisson, 1993).

The use-wear traces from hide working on the assemblages included in the PCR project indicate hide-defleshing by cutting on hides in a fresh and/or intermediate state at the sites of Fonseigner and Chez-Pinaud. Scraping actions, mostly on dry skins, at Fonseigner and, to a lesser extent, Grotte du Noisetier, Mauran, and Coudoulous, could correspond to defleshing of dry hide, or to some

Chez-Pinaud
(drawings: S. Pasty; photographs: EC)
a - CPN E19 888, flint
b - CPN E19 563, flint
c - CPN E12 800, flint
d - CPN E12 525, chalcedony
use: cutting of hide (fresh/moist?)
e - CPN E16 641, flint
f - CPN E14 921, flint
g - CPN E15 269, flint
use: cutting of hide (intermediate state?)
h - CPN D16 275, flint
use: cutting of soft cutaneous material
(fresh / moist, skinning?)

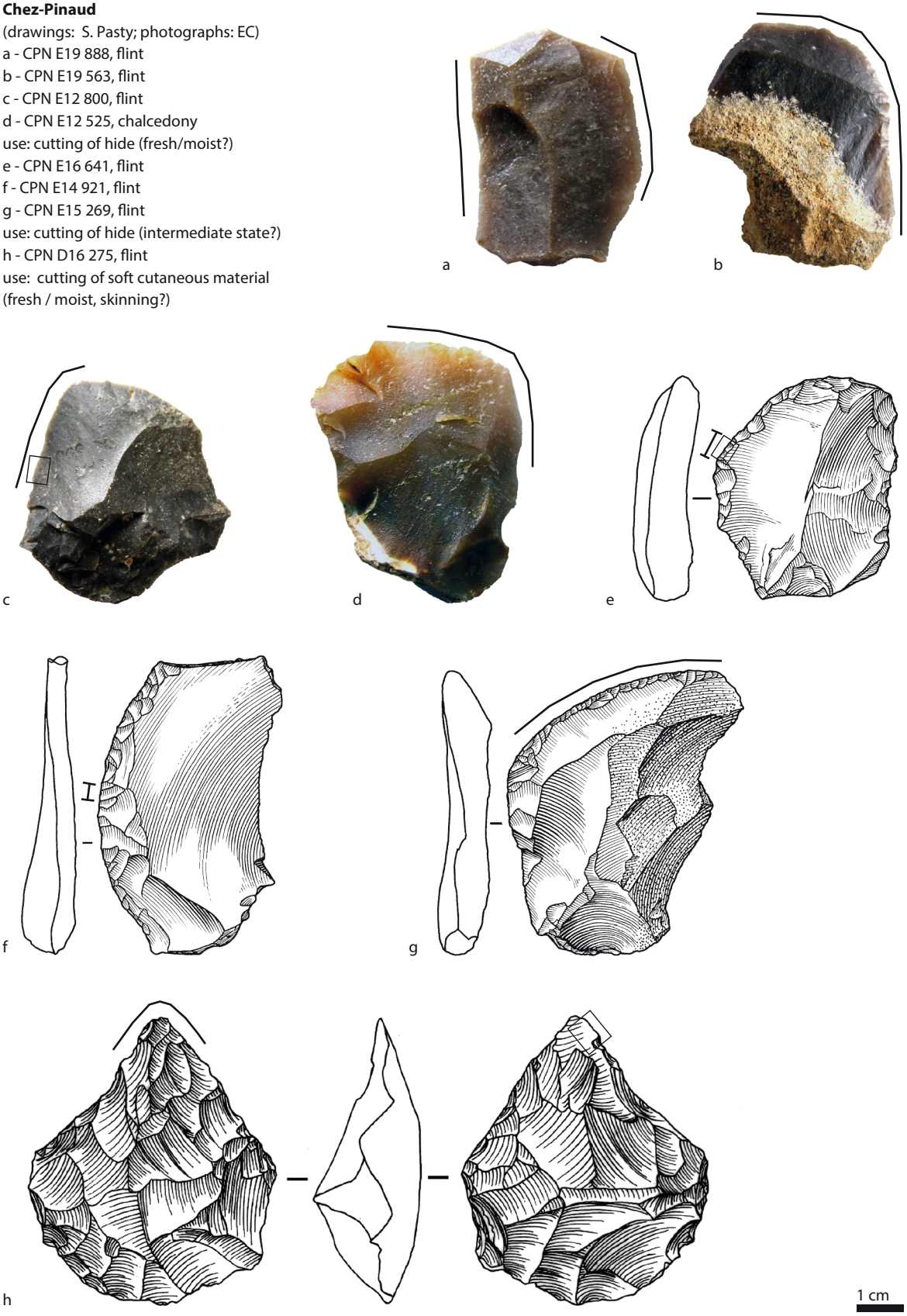
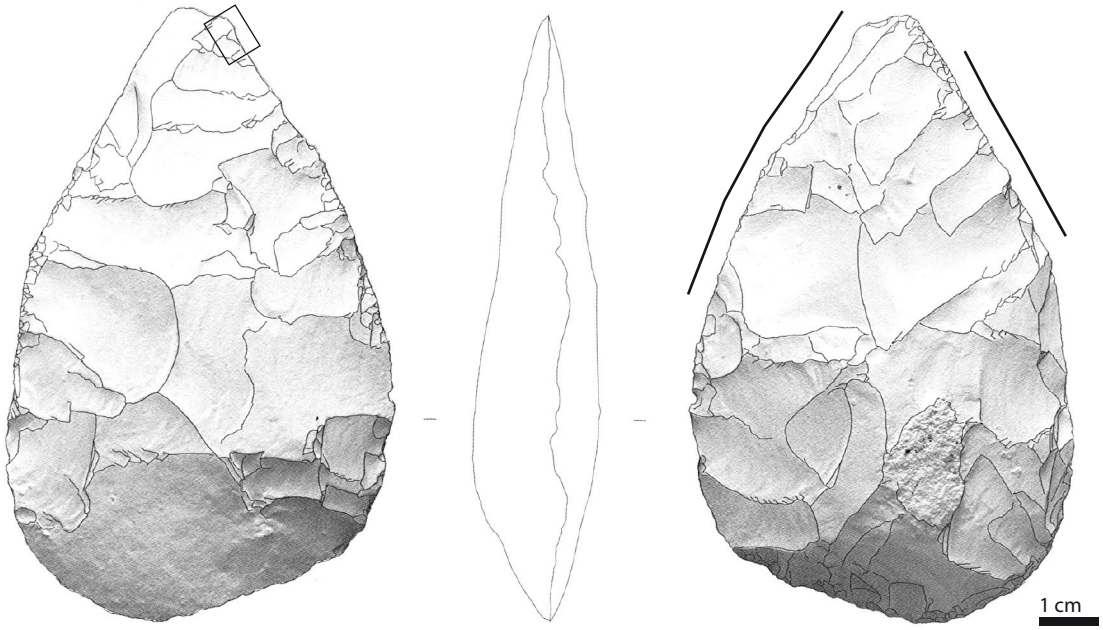
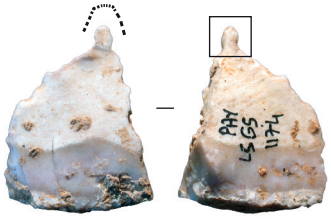


Figure 235 - Unmodified flakes, side scrapers and biface from the site of Chez-Pinaud used or probably used in the context of hide working, in a longitudinal action. The black rectangles indicate the locations of the photographs of the use-wear traces presented in figure 182[b-d] (CAD: É. Claud and M. Coutureau).

Chez-Pinaud
(drawings: J. Airvaux)
CPN 03 D18 s4 7s 5,55-5,60, flint
use: cutting of a cutaneous material (left edge)
and a cutaneous or meaty material (right edge) (fresh or moist, skinning?)

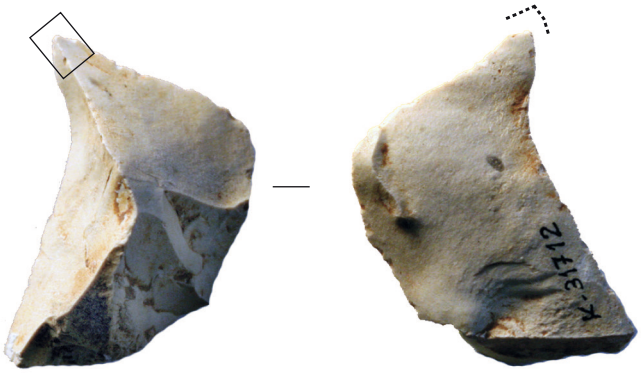


Payre
(photographs: AC)
PAY LS G5 1174, flint
use: perforation of a soft to medium-hard material (hide?)



Mauran
(photographs: CT)
M 75 II D19 5, quartzite
use: perforation of a soft material (hide?)

Les Fieux
(photographs: CT)
K 31712, flint
use: perforation of a soft material (hide?)



cutting
perforation

Figure 236 - Biface from the site of Chez-Pinaud used in a longitudinal action on hide and a tool and pointed flakes from the sites of Payre, Mauran and Les Fieux used to perforate a material that could have been hide. The black rectangles indicate the locations of the photographs of the use-wear traces presented in figures 182[a] and 184[c-d] (CAD: É. Claud and M. Coutureau).

Fonseigner
(drawings: J.-M. Geneste and J.-G. Marcillaud; photographs: EC)
a - Fons 77 Z1 192 Dsup 19 A, flint
b - Fons 77 A2 Dsup 18, flint
c - Fons 77 Z2 Dsup 02 17, non-local flint
d - Fons 9 Z1 Dsup 15, flint
e - Fons 77 Z3 Dsup 11 20, flint
use: cutting hide (intermediate state?)
f - Fons Z3 Dsup 24, flint
g - Fons 77 Z23 Dsup 14, flint
h - Fons 77 A3 Dsup 80 22, flint
i - Fons 77 Z23 Dsup 12 23, flint
j - Fons 77 Z5 Dsup 01 21, flint
use: scraping of an abrasive soft to medium-hard material like dry hide
k - Fons A4 77 Dsup 26, flint
use: scraping (and cutting) of an abrasive soft to medium-hard material like dry hide

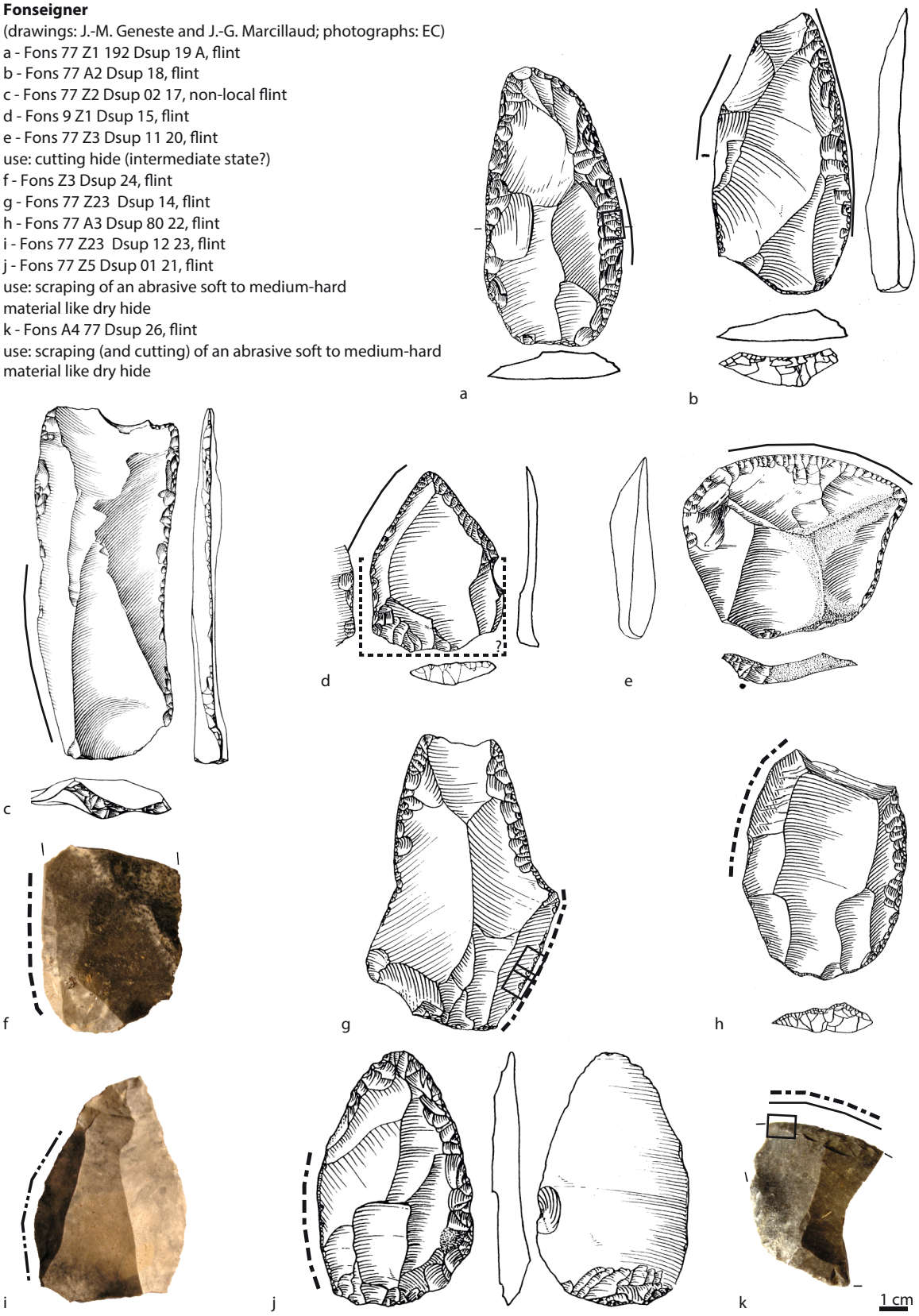


Figure 237 - Unmodified flakes and scrapers from the site of Fonseigner used or probably used in cutting and scraping hide. The black rectangles indicate the locations of the photographs of the use-wear traces presented in figure 183 (CAD: É. Claud and M. Coutureau). Solid line: location of the traces from cutting; dashed line: location of the traces from scraping; dotted line: limits of the potentially hafted zone.

Grotte du Noisetier
(photographs: EC)
NS06 C15 c2 147, quartzite
use: scraping an abrasive soft material like dry hide

Coudoulous
(photograph: FV)
COU I 4 2006, quartz
use: cutting dry hide

Figure 238 - Unmodified flakes from the sites of Grotte du Noisetier and Coudoulous used or probably used in the context of working dry hide, in scraping (Grotte du Noisetier) and cutting (Coudoulous). The black rectangle indicates the location of the photographs of the use-wear traces presented in figure 184[a-b] (CAD: É. Claud and M. Coutureau).

other activity. The cutting of dry hide at Coudoulous and perforation of hide at Mauran and Les Fieux are noted anecdotally and cannot be confidently interpreted in terms of specific activities. The tools used in hide working are primarily unmodified flakes and scrapers, with fairly homogenous morpho-functional characteristics: convex in plan, rectilinear in profile, biplanar or plano-convex in cross-sections, and with a low to moderate edge angle (30°-55°). A few bifaces and a single Mousterian point bear traces of cutting-hide but their morphology suggests that they would have served some purpose other than hide-defleshing, such as making the initial incisions in the hides. No traces related to hide working were identified on denticulates and notched pieces.

What can other use-wear analyses tell us about hide working in the Middle Palaeolithic of Western Europe?

First of all, several studies mention pieces used to cut fresh hide or hide of an unspecified state, or soft animal tissues including meat or hide, in which case hide working is as likely as butchery. This is notably the case at Lichtenberg (Veil *et al.*, 1994), Maastrich-Belvédère, site B-G (van Gijn, 1989b), Les Tares (Geneste, Plisson, 1996) and San Quirce (Clemente-Conte *et al.*, 2012).

Hide working is identified in a little more than 40 assemblages (table 69), with different technological characteristics (Levallois, Discoidal and Quina debitage, ...). The raw materials used are flint and, to a lesser extent, quartzite and quartz (Tunnelhöle, Axlor, Cueva Morin, and Cova Eiros).

		Modes of use	Tool types
Germany	Gröbern	hide working	flakes
	Lichtenberg	cutting meat or hide, probably during butchery	7 bifacial tools (*Faustkeilblatt*, *Keilmesser*)
	Salzgitter Lebenstedt	fresh hide processing (no data about the motion used)	Levallois flakes
	Sesselfelsgrotte	scraping hide	few tools, non detailed
Austria	Tunnelhöle	scraping dry hide	atypical scraper and retouched pseudo-Levallois point
Begium	Rémicourt	scraping hide	unretouched point (broken, traces on a lateral edge)
	Spy	cutting dry hide (1), piercing dry hide (1, maybe 2)	2, maybe 3 Mousterian points
Netherlands	Maastricht-Belvédère (site J)	cutting hide	15 pieces: unretouched flakes (resharpening flakes, laminar flakes), scrapers (including double scrapers with traces on both lateral edges), Mousterian point (2 edges used). Resharpening evidences of the scrapers
		scraping hide	3 scrapers and 1 unretouched flake
		undetermined motion on hide	2 scrapers
	Maastricht-Belvédère (sites B-G)	cutting meat and hide (butchery)	1 large blade (cutting hide)
England	La Cotte de Saint Brelade	hide working by cutting and scraping (not detailed per tool type)	70 active zones: 37 scraper resharpening flakes, including a retouched one, 8 scrapers, 3 notches, 2 endscrapers, 3 burins, 1 knife, 2 raclettes, 3 denticulates, 1 retouched Levallois point, 2 retouched flakes, 3 miscellaneous, 1 broken tool, and 4 burin spalls
Northern France	Beauvais	scraping dry or tanned hide	1 pseudo-Levallois point
	Biache-Saint-Vaast	scraping hide	non convergent and elongated scrapers (although not documented in the study of Rots, 2013)
	Corbehem	hide working (no data about the motion used)	1 waste or core
	Grotte du Renne	hide working (no data about the motion used)	1 scraper
	Le Pucheuil	scraping hide (including dry hide)	"Le Pucheuil" flake
	Riencourt-lès-Bapaume	scraping fresh hide	6 denticulated scrapers with a convex edge
		scraping dry hide (placed on a hard and convex surface?)	5 retouched notches with a concave edge
	St-Brice-sous-Rânes	hide working	1 scraper
North Center France	La Folie	cutting dry hide	1 Levallois flake
		scraping dry hide	4 flakes and 1 endscraper
South Western France	Bout des Vergnes	cutting of a soft and abrasive material such as hide	1 biface (traces located in a very small area that was not resharpened)
	Combe-Grenal (layers 21 to 24)	hide working (no data about the motion used)	13 Quina scrapers
	Canolle	cutting of a soft and abrasive material such as hide	1 scraper that was also used for butchery (traces on another edge)
	Cantalouette II	scraping hide (undetermined condition, dry and ochred)	18 undetailed pieces
		cutting hide, including dry hide	2 undetailed pieces

		Modes of use	Tool types
South Western France	Corbiac	scraping hide	4 scrapers with a convex edge, 2 bifaces
	Grotte XVI	scraping hide	2 bifaces
	Chez-Pinaud (US 22)	cutting fresh hide (probably for defleshing)	21 pieces: Quina (10) and scraper manufacturing flakes, that were retouched into scrapers (10) or unmodified (1). Quite elongated tools, bearing active zone with convex delineation, straight profile and biplanar or plano-convex section, and average cutting angles of 47°±9° (27°-62°). Several evidences of resharpening.
		scraping dry hide, with a opened leading angle	1 manufacturing flake that was retouched into a scraper, with a very convex active zone (cutting angle: 58°)
	Abri du Musée	scraping non fresh hide	1 undetailed tool
	Latrote	scraping non fresh hide and dry hide	1 simple scraper,1 transversal scraper, 1 endscraper fragment
		cutting hide (dry or moist hide?)	1 simple scraper
		scraping soft material (hide?)	2 scrapers (transversal and double), 1 Mousterian point, 1 endscraper
		cutting soft material (hide?)	1 cortical backed blade
	Les Tares	cutting meat or hide, probably during butchery	scrapers on cortical flakes coming from Quina debitage and thin scrapers on cortical backed flakes
	Marillac	hide working (no data about the motion used)	1 denticulate and 1 miscellaneous
	Vaufrey	hide working (no data about the motion used)	2 scrapers, 1 cortical backed knife, 1 notch
	Pech de l'Azé I	scraping hide	2 bifaces + 1 simple scraper with convex edge
	Pech de l'Azé IV	scraping hide	2 bifaces + 2 simple scrapers with convex edge
South Eastern France	Champ-Grand	scraping dry hide	1 scraper, 1 blade, 3 limaces
		piercing dry hide	1 pointed bladelet
	La Combette (level D)	defleshing fresh hide (scraping, cutting, mixed motion, 4 active zones)	17 pieces: few unmodified flakes, many scrapers (including one with hafting traces), with an active zone that has a convex delineation and a straight profile (and a plano-convex section in the case of scraping non fresh and dry hide) and a cutting angle between 40° and 80°. Selection of large blanks, often cortical and with long and regular edges
		cutting hide on a limestone pebble (to make buttonholes, with a pointed flake)	
		working hide in various conditions: non fresh, dry, treated with animal fats (brain, liver...), mainly by scraping, with an opened or a low leading angle (+ 2 by cutting and 1 by mixed action): proto-tanning (13 active zones)	
	La Combette (levels A and B)	defleshing fresh hide (by cutting and indetermined motion) (3 pieces)	13 undetailed pieces (including scrapers)
		piercing fresh hide (buttonholes) (1 piece)	
		working non fresh and dry hide, by scraping (4), cutting (2) and mixed motion (2): proto-tanning (8 active zones)	
Italy	Fumane	cutting non fresh hide	1 Quina scraper
	Grotta Breuil (layer XX)	scraping fresh hide, with an opened or a low leading angle (defleshing) (9 active zones)	many scrapers (rare unmodified flakes, including a cortical one), with an active zone that has a convex or straight delineation (excepted for piercing: pointed convergent scraper) and a cutting edge angle between 40° and 100° (average of 72°), that is more opened on tools used for proto-tanning than for those used for defleshing
		cutting fresh hide (defleshing) (3 active zones)	
		scraping moist, non fresh or dry hide (proto-tanning) (7 active zones)	
		piercing non fresh hide (1 active zone)	
		cutting dry hide (1 active zone)	

		Modes of use	Tool types
Italy	Grotta Breuil (layer 6)	cutting, scraping and mixed motion on fresh hide (defleshing) (6 active zones)	many unretouched flakes, with an active zone that has a straight profile and a low cutting edge angle (average of 43°, the most opened angles were observed on tools working dry hide) and a convex, straight (on tools used on fresh or non fresh hide) and concave (on tools used on dry and fresh hide) delineation
		scraping non fresh and dry hide (proto-tanning) (2 active zones)	
		cutting and indetermined motion on non fresh an dry hide (3 active zones)	
	Grotta Breuil (layer 3)	cutting, scraping and indetrmined motion on fresh hide (defleshing) (21 active zones)	unmodified flakes and scrapers, with an active zone that has a biplanar section (mostly for defleshing), a straight profile, a straight, convex or concave delineation (mainly straight for cutting motion and convex for scraping motion) and a cutting edge angle most often between 29° et 59° (the lowest values were observed on tools used for cutting and scraping with an opened leading edge)
		scraping moist, non fresh and dry hide (proto-tanning) (10 active zones)	
		cutting moist, non fresh and dry hide (3 active zones)	
Iberian Peninsula	Abric Romaní (levels H, I, Ja)	scraping fresh hide (defleshing)	8 pieces: unmodified flakes and denticulates
	Abric Romaní (level 0)	scraping hide	1 Levallois retouched flake (scraper?), 1 retouched Levallois point (traces located on the retouched edge)
	Amalda	scraping hide	1 endscraper-scraper, 1 Quina scraper, 1 double scraper, 2 flakes (in flint)
	Axlor	working fresh hide (mainly by scraping)	scraper resharpening flakes (in flint and quartzite)
		scraping dry hide	scrapers (in flint and quartzite)
	Bajondillo Cave	scraping fresh hide (3), dry hide (2) and hide in an indetermined condition (7), and cutting hide (1)	scrapers, endscrapers, unmodified flakes, with a convex active zone and a cutting edge angle between 40° and 80°
	Cova Eiros	scraping dry hide	1 scraper, 1 endscraper, 1 Levallois flake, 1 flake retouched into a denticulate after use (in quartz and quartzite)
	Cueva Morín (layers 16 and 18)	working freh hide (mainly by scraping)	scraper resharpening flakes (in flint and quartzite)
		scraping dry hide	scrapers, Mousterian point, scraper resharpening flakes (in flint and quartzite),
		cutting dry hide	1 pseudo-Levallois point (in flint)
		cutting non dry hide	1 unretouched flake (in quartzite)
	El Salt	scraping hide	2 scrapers, 1 Levallois flake (in flint)
		cutting and scraping hide	1 scraper (in flint)
	Ribeira Ponte da Pedra / Atalaia	cutting soft material (hide?)	1 flake
	San Quirce	cutting soft animal material (meat or hide)	11 flakes and 2 choppers (in quartz and quartzite)

Table 69 - Published data on Middle Palaeolithic assemblages in Western Europe that have yielded traces of hide working and the types of pieces that have presented such traces. See Annex 1 for the literature references.

Hide working is evidenced with varying frequency in the different assemblages: from one or two pieces (including assemblages that were thoroughly examined, such as Rémicourt, Corbehem, Grotte du Renne, Les Pradelles, Bout des Vergnes, Canolle, and Fumane) to greater numbers at sites such as Chez-Pinaud (US 22), Latrote, La Combette (level A/B), Abric Romaní, and Grotta Breuil (layers 3 and 6). Hide working is the best-represented activity in terms of the number of active zones at Maastricht-Belvédère (Site J), La Cotte de Saint Brelade, Cantalouette II, La Combette (level D), and Grotta Breuil (layer XX). It has not been identified on any of the pieces from the following assemblages, in spite of thorough analysis: Havrincourt sectors 1 and 2 (Goval *et al.*, 2013), Bettencourt-Saint-Ouen (Locht *et al.,* 2002), Pié-Lombard (Beyries, 1987a), Combe-Grenal, layer 3 or F (13)

(Beyries, 1987a), Les Bessinaudes (Chadelle *et al.,* in preparation), and Bayonne Jupiter PM1 and PM2 (Colonge *et al.*, 2015). With regard to the site of Biache-Saint-Vaast, though the study of S. Beyries (1988b) mentioned the use of several non-convergent and elongated side scrapers for the hide-scraping, V. Rots (2009) does not mention any such tools in her analysis, which focused in large part on retouched tools, including side scrapers. It is therefore possible that the traces identified by S. Beyries should be called into question by the more recent study.

The dominant modes of use for tools dedicated to hide working are cutting and scraping; perforation is rarely noted (one or two Mousterian points at Spy, one piece at Grotta Breuil layer XX, one piece at La Combette level A/B, and one bladelet at Champ-Grand).

The hides worked were in fresh, dry, moist, or intermediate states. At La Combette, some tools appear to have been in contact with an additive of animal origin, such as brain, liver, or fat, probably added as for proto-tanning (Lemorini, 2000). At Cantalouette II, ten pieces were used to scrape hide coated with ochre. Amongst the assemblages in which hide working is well represented, several provide evidence that hides in different states were worked: Riencourt-lès-Bapaume, La Combette, Grotta Breuil or Bajondillo Cave. At Abric Romaní, however, only traces of scraping fresh hide were detected (Mártinez-Molina, 2005). Similarly, in the assemblage from Chez-Pinaud US 22, there is only one piece that was used to scrape dry hide, while 21 pieces were used to cut fresh hide. The sites of Cova Eiros and Champ-Grand yielded evidence exclusively indicative of working dry hide.

The working of fresh hides is often associated with the hide-defleshing phase, whether by cutting or scraping. It has been identified at several sites, on different types of tools: Levallois flakes at Salzgitter Lebenstedt, side scraper-denticulates of convex morphology at Riencourt-lès-Bapaume, Quina side scrapers and scraper manufacturing flakes at Chez-Pinaud US 22, retouched Quina side scrapers at La Combette, unmodified flakes and denticulates at Abric Romaní, side scraper resharpening flakes at Axlor and Cueva Morín, and side scrapers and unmodified flakes at Grotta Breuil. At La Combette, a flake from level D has been interpreted as having been used to cut skin that was laid against a limestone cobble. In levels A/B at the same site, a piece was used to cut through fresh hide, probably in a similar manner, specifically the creation of buttonholes.

The tools that were used in scraping, in cutting, or in perforation on hides that were not fresh (dry, moist, of intermediate) are either assigned to the proto-tanning phases (La Combette, Grotta Breuil), or have not been interpreted in terms of the hide-processing sequence. Different types of tools were used. The scrapers, with or without Quina retouch, were used in scraping (Tunnelhöle, Latrote, Chez-Pinaud US 22, La Combette, Champ-Grand, Axlor, Cueva Morín, Cova Eiros) and sometimes also in cutting (La Combette, Latrote, Fumane). Unretouched blanks used for scraping are also mentioned (Tunnelhöle, Beauvais, Le Pucheuil, La Folie, La Combette, Champ-Grand, and Grotta Breuil), as were some endscrapers (La Folie, Latrote, Cova Eiros), *limaces* (Champ-Grand) and, more rarely, retouched notches (Riencourt-lès-Bapaume). In addition to side scrapers, pieces used to cut hide include unmodified flakes (La Folie, La Combette, Grotta Breuil) and Mousterian points (Spy).

There is another type of tool not yet listed that sometimes bears traces of contact with hide in an unspecified state: bifaces, used in cutting at Bout des Vergnes (one piece) and in scraping at Grotte XVI (two pieces), Pech de l'Azé I (two pieces) and IV (two pieces). Nonetheless, as emphasized earlier, the results of these last studies cited may require revision. Denticulates, burins, notched pieces, and one backed knife that bear polish from hide have been noted at La Cotte de Saint Brelade, though the mode of action is not specified. S. Beyries also noted a notched piece and a naturally-backed knife that bear micro-polish from hide working at Vaufrey. Once again, these earlier studies provide few micro-photographs that would allow for an evaluation of their claims, and must be interpreted with caution. Finally, the two edges of a Mousterian point served to cut hide at Maastricht-Belvédère, site J.

With regard to the morphological characteristics of the active zones, the information provided varies considerably from one study to another, in terms of precision as well as content. At the sites of Chez-Pinaud US 22, La Combette, Grotta Breuil, and Bajondillo Cave, the active zones on unmodified flakes and side scrapers (which dominate at La Combette and Chez-Pinaud), are frequently convex in plan, rectilinear in profile and biplanar or plano-convex in cross-section, with sharp and fairly low cutting-edge angles (40° to 50° on average) for cutting and scraping with a positive rake angle (Grotta Breuil, 3) and higher edge angles (55° to 80° or even 100°) for scraping with a negative rake angle, especially dry hide.

At La Combette and Grotta Breuil, the tools with plano-convex sections are reserved for scraping hides that are dry, moist, or intermediate. The tools used for hide-defleshing tend to have lower edge angles and biplanar cross-sections. The morphologies in plan view are sometimes rectilinear or concave (notably at Grotta Breuil, 3 and 6), and tools of the latter type seem dedicated to cutting actions (according to the images provided) on hide of undetermined state.

At Riencourt-lès-Bapaume, S. Beyries (1993) has described two groups of tools used in scraping hide: side scraper-denticulates with a convex outline for scraping fresh hide and retouched notches with a concave outline for scraping dry hides. A hypothesis advanced by the author is the use of a hard convex support (possible wood) placed under the hide to facilitate the scraping of dry hides. The edge angles and the sections are not mentioned but it is surprising to see denticulated edges, even with teeth that are not very pronounced, interpreted as hide-scraping tools given the risk they pose of damaging the hides. The scraping of fresh hide with denticulates at Abric Romaní is also unusual (Mártinez-Molina, 2005), with the use-wear localised either along the denticulated edge or the interior of a notch. The active zones are thus denticulated or concave in plan. It is difficult to imagine that one could effectively deflesh fresh hide with such tools, as denticulations could tear the hide and the interior of a notch is also poorly adapted to the task.

In general, according to our experiments, defleshing fresh hide is only really possible by tangential cutting; scraping, regardless of rake angle, does not neatly remove large quantities of tissue on the interior surface of the hide. Scraping of fresh hides, therefore, does not necessarily indicate hide-defleshing, especially if the tools are irregular in outline or possess high edge angles. The use of denticulates or notches and, more generally, denticulated or concave active zones for scraping hides could correspond to the working of narrow strips of skin, such as thongs, but the freshness of the hide poses some questions in that regard. One hypothesis that presents itself is the removal of hair from strips of hide, but this is easier to achieve by soaking. Removal of remaining hairs after the soaking of thongs is also a possibility.

Several studies mention the resharpening of side scrapers over the course of hide working. This is the case for side scrapers at Maastricht-Belvédère and side scrapers of the Quina type at Chez-Pinaud US 22, used to cut hide (fresh at Chez-Pinaud; Roebroeks *et al.*, 1997; Claud *et al.*, 2012) and side scrapers at Axlor and Cueva Morín, where the old edges of side scraper resharpening flakes bear traces of scraping fresh hide (Lazuén, 2012a; Lazuén, Gonzales-Urquijo, 2014). The resharpening of side scrapers further demonstrates the need to work with sharp edges, and is therefore coherent with hide-defleshing activities, notably by cutting, which dulls the edges fairly slowly (in comparison to scraping dry hide) but absolutely requires a sharp cutting edge. In US 22 at Chez-Pinaud, hide was cut with debitage flakes from manufacturing bifacial scrapers that were retouched into scrapers before use (only one is unmodified), which were used in butchery in their unmodified state. At this site, it therefore seems that retouching was used to adapt the morphology of the flake edges to specific activities (probably hide-defleshing) by making them more regular and convex in plan.

Finally, side scrapers were sometimes used to perform multiple actions on hide, fresh or not, from scraping to cutting, like those already mentioned at La Combette and Grotta Breuil.

In the end, the tools used in hide working are primarily side scrapers and unmodified flakes, by cutting or scraping (figure 239, tableau 70). Tools that present traces of both actions have been observed at several sites. Side scrapers were probably subjected to frequent rejuvenation, especially during the defleshing of fresh hide by tangential cutting. As a matter of fact, it is this phase that required the sharpest tools (low edge angles, biplanar section), even if certain edges used in scraping at a wide positive rake angle also have low edge angles (Grotta Breuil, Fonseigner). It is possible that certain unmodified flakes were turned into side scrapers by resharpening, but in US 22 at Chez-Pinaud the debitage flakes appear to have been shaped into scrapers before use. Generally, the edges used (especially in scraping) are convex in plan, but in rare cases (Riencourt-lès-Bapaume, Abric Romaní) they are denticulated or concave. Some Mousterian points were used to cut or even pierce hide (Maastricht-Belvédère, Spy, Fonseigner, Cueva Morín), some endscrapers and *limaces* were used in scraping, and some few bifaces in cutting hide.

The difference between sites in terms of the frequencies of tools identified as having been used in hide working could result from the use of implements (lithic or not) of types other than those studied. Indeed, though defleshing hide that still has bits of flesh clinging to it is a necessary step, it can be achieved, on fresh hides, with sharp tools in non-lithic materials, such as bone. The defleshing of dry hides, as well as other phases of the *chaîne opératoire* like thinning or softening, can also be performed with bone tools, cobbles, or even by rubbing the hide against a tree-trunk with abrasive bark. At Combe-Grenal, several fragments of bone show blunt tip on one or both extremities that is characteristic of rubbing against a soft material, which could correspond to hide (Tartar, Costamagno, 2016). At Axlor, a fragment of retouched bone from layer N presents a polish characteristic of hide working (Mozota Holgueras, 2012). Some few objects in bone that may have served as hide-working tools[5] have been identified at sites including Vaufrey, La Ferrassie (see Tartar, Costamagno, 2016), Abri Peyrony and Pech de l'Azé I (Soressi *et al.*, 2013), Abric Romaní (Carbonell *et al.*, 1996) and Grotte du Noisetier (Oulad el Kaï, 2016).

This disparity in frequency could also be the result of the degree to which butchery and skinning activities were broken up over time and space, and on site function. At certain sites that present a relative diversity of tools related to hide working, associated with distinct modes of action and hides of different states of freshness, one might conclude an operational sequence of hide-treatment at the site, including hide-defleshing (especially by cutting) followed by proto-tanning. Such is the case at Riencourt-lès-Bapaume, Fonseigner, La Combette, Axlor, Cueva Morín, Grotta Breuil and Bajondillo. At these sites hide working is not necessarily the dominant activity documented in terms of active zones, but it is often in second place, after butchery or woodworking. At other sites, fresh hide working is the exclusive or dominant activity, and accompanied by a large number of tools related to butchery. These sites include Salzgitter Lebenstedt, Chez-Pinaud US 22, Chez-Pinaud US 06/07, Abric Romaní, and perhaps Maastricht-Belvédère site J, where the state of the hide is not mentioned (but cutting clearly dominates scraping and butchery is well represented). These sites were most likely primarily dedicated to the processing of carcasses, by butchery as well as the cleaning of hides. The assemblages in which the working of fresh hide is not highlighted and which have been subjected to thorough analysis most often yield a limited number of tools related to hide working, which could suggest their use in the maintenance, rather than fabrication, of objects made of hide. Such sites include Abri du Musée, Champ-Grand, Cova Eiros, Latrote, Coudoulous, Grotte du Noisetier and Mauran. With regard to the latter four sites, caution is advised because the scarcity of traces related to the working of dry hide and absence of traces

5. However, a bone scraper from Fumane presents traces related to the scraping of wood (Romandini *et al.*, 2014a).

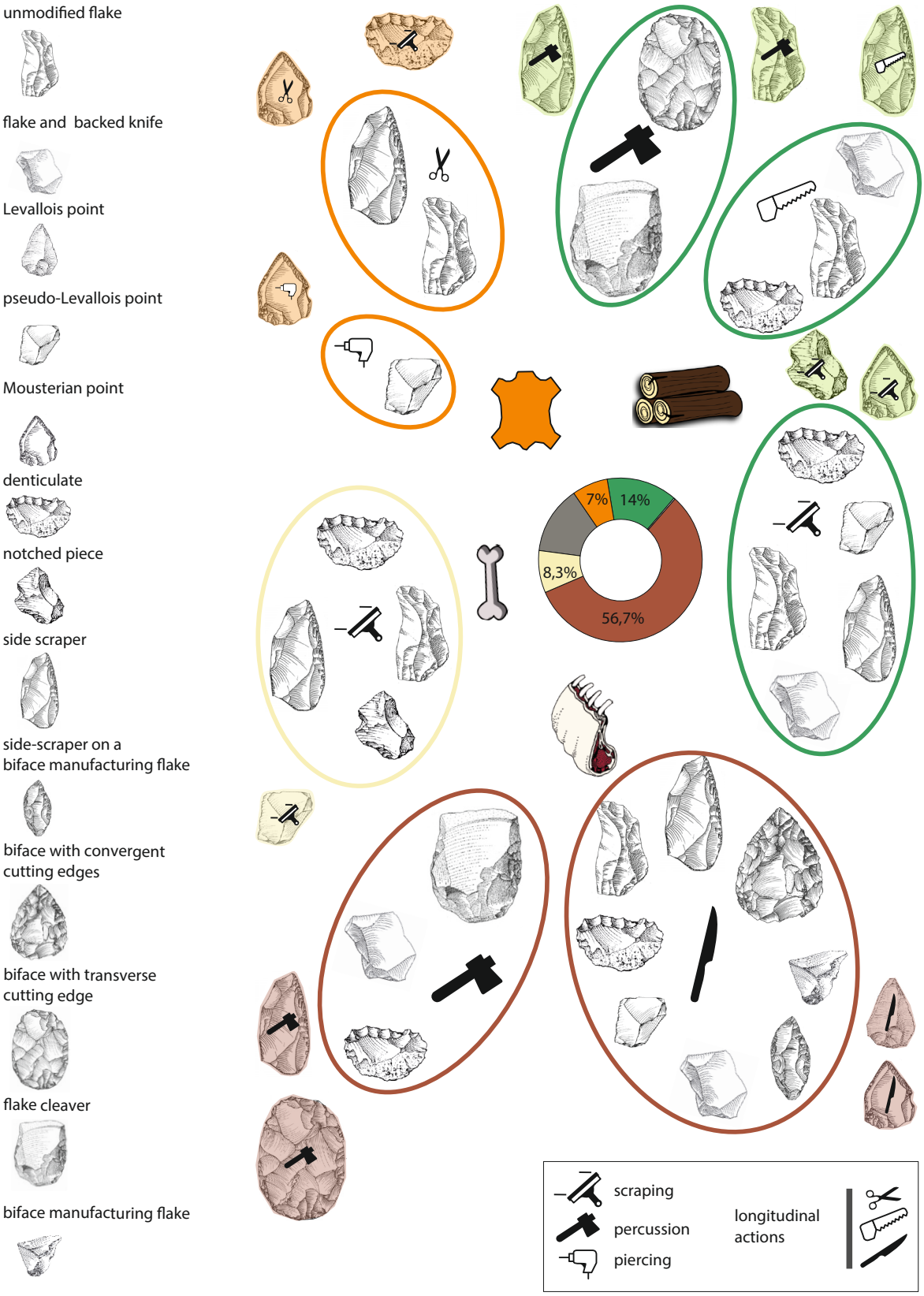


Figure 239 - Schematic summary of the primary tools used, according to activity. The colour drawing of a tool, located outside the circles, indicates that the function of this tool type was primarily identified in the literature (CAD: É. Claud and M. Coutureau). Drawings after Geneste, 1985; Farizy *et al.*, 1994 (drawing: J. Jaubert); Locht *et al.*, 2002; Thiébaut, 2005; Jaubert *et al.*, 2008 (drawings: F. Brenet); Deschamps, 2014; Brenet *et al.*, 2016 (drawings: F. Brenet) and Deschamps *et al.*, 2016 (drawing: P. Rouzo).

	Data from PCR studies				Bibliographic data	Synthesis of the main tools used
	Nb of AZ	Sites	Tool types	Characteristics of the active zones		
Wood						
Percussion / chopping	8	El Castillo, Gatzarria, Olha I, La Graulet, Chez-Pinaud	FLAKE CLEAVERS, bifaces with a distal transverse edge (scraper)	unmodified or bifacially shaped, with a convex delineation and a medium cutting edge angle (44° ± 9°), located in the distal part of the tools	bifacial tools with distal transverse edge, flakes with bifacial retouch, Levallois flakes, scrapers, flake cleavers	bifacial tools with a distal transverse edge and flake cleavers
Longitudinal motion (sawing ?)	22	Coudoulous, Payre, Chez-Pinaud, Les Fieux, Mauran, Fonseigner	UNMODIFIED FLAKES, denticulates, backed knives (scraper)	unmodified or retouched into denticulates, with various morphologies and cutting edge angles	unmodified flakes, backed knives or flakes, denticulates, blades, Levallois point, Levallois flake, Mousterian point, scraper retouching flake, endscraper, scrapers, bifaces	various unmodified blanks + tools
Scraping	38	Coudoulous, Payre, Chez-Pinaud, Les Fieux, Mauran, Fonseigner	UNMODIFIED FLAKES, pseudo-Levallois points, scrapers, denticulates (notche)	unmodified or retouched into denticulates or scrapers, short, often with straight or concave delineations and various cutting edge angles	unmodified flakes, pseudo-Levallois points, Levallois points, Mousterian points, denticulates, notches, scrapers (including bifacial ones), endscrapers, scraper resharpening flakes, burins, bifaces	various unmodified blanks + tools
Animal resources						
Hunting	2	Coudoulous	triangular flakes	pointed tip of quartz flakes	pointed flakes (retouched or not), Levallois and Mousterian points, convergent scrapers, pseudo-Levallois points, Soyons points, Levallois micro- and nano-points	various unmodified and retouched blanks, with a pointed morphologya
Butchery by cutting	255	Bayonne le Prissé PM1, PM2, Chez-Pinaud, Coudoulous, Fonseigner, La Grotte du Noisetier, Les Fieux, Mauran, Saint-Césaire, La Conne de Bergerac, Combe Brune 2, Payre	UNMODIFIED FLAKES, SCRAPERS, DENTICULATES, BIFACES with convergent edges, biface manufacturing flakes (retouched into scrapers or not), pseudo-Levallois points, backed knives or flakes (Mousterian points, Levallois points, retouched flakes, notches, endscrapers, limace)	often unmodified (60 %), sometimes retouched into scrapers, denticulates, bifaces or points, long, with a low to medium cutting edge angle, often less than 50°, and various delineations, although the frequent presence of a convergent or angular area is noted	unmodified flakes, pseudo-Levallois points, core edge flakes, cortical backed knives, Levallois flakes, Levallois points, Kombewa flakes, laminar flakes, blades, Quina scraper and biface manufacturing flakes, scraper retouching or recycling flakes, bifaces, bifacial tools, scrapers, Mousterian points, denticulates, choppers	various unmodified blanks + various tools although dominated by scrapers, denticulates and bifaces with convergent edges
Chopping medium hard to hard material (probably carcasses)	22	Chez-Pinaud, El Castillo, Olha I, Les Fieux, Saint-Césaire	FLAKE CLEAVERS, backed flakes, denticulates (scrapers, notche, *bec*)	often unmodified, with medium cutting edge angles (54° ± 9° for flake cleavers and 50° ± 7° for the other tools), various delineations, associated with a backed area (prehension area)(excepted on flake cleavers)	scrapers, *hachoir*, retouched backed flakes, preferential Levallois flakes, *Faustkeile*, unmodified flakes, bifaces with a natural base and a distal transverse edge, choppers, cleaver	flake cleavers, backed flakes with unmodified or retouched edge, bifaces with a distal transverse edge
Scraping hard and organic material (probably butchery)	41	Les Fieux, Mauran, Chez-Pinaud, Saint-Césaire, Coudoulous	UNMODIFIED FLAKES, scrapers, denticulates, notches, retouched flakes (endscrapers, backed knives / flakes, biface, pseudo-Levallois point)	often unmodified, with various cutting edge angles and deli-neations, although frequently straight or concave	unmodified flakes, backed flakes, recycling flakes, pseudo-Levallois points, bladelets, scrapers, denticulates, limaces	various unmodified blanks + scrapers and notched pieces
Cutting hide	22	Chez-Pinaud, Coudoulous, Fonseigner	SCRAPERS, unmodified flakes (bifaces, Mousterian point: for these two last tools skinning is not excluded)	unmodified or retouched into scrapers, with a convex deli-neation and a low to medium cutting edge angle (30°-51°)	unmodified flakes, scrapers (including on Quina scraper manufacturing flakes), Mousterian points, Levallois flake, biface, pseudo-Levallois point	scrapers and unmodified flakes
Scraping hide	11	Coudoulous, Fonseigner, Grotte du Noisetier, Mauran	SCRAPERS – used edge is unmodified or retouched, unretouched flakes (core edge flake)	unmodified or retouched into scrapers, with a convex deli-neation and a medium cutting edge angle	scrapers, unmodified flakes, denticulated scrapers, retouched notches, endscrapers, limaces, denticulates, Mousterian points, unmodified and retouched pseudo-Levallois points, Levallois flake, blade, bifaces	scrapers and unmodified flakes
Piercing hide	2	Les Fieux, Mauran	pseudo-Levallois points	unmodified and pointed	Mousterian point, pointed bladelet, convergent and pointed scrapers	various pointed blanks, retouched or not

Table 70 - Summary of tools identified for each activity and the characteristics of the active zones. See Annex 1 for the literature references that appear in the "bibliography" column. In the column "type of tools," the capital letters correspond to the tools most frequently identified and those in parentheses were only rarely identified.

related to the working of fresh hide could be the result of: problems of preservation at Grotte du Noisetier and Mauran, the use of flint tools (excluded from analysis for reasons of preservation) in hide working at Coudoulous, and the use of quartzite at Latrote. Only the site of Cantalouette II yielded a substantial quantity of tools related to working dry hide, sometimes treated with mineral pigments. For certain pieces, the state of the hide was not determined, and the processing of fresh hides cannot be excluded.

4 - Raw materials, tools and activities: can functional specializations be identified?

(É. Claud, C. Thiébaut, M. Brenet, M. Deschamps, D. Colonge, V. Mourre)

A - The raw materials

Incorporating archaeological assemblages into our study with a certain diversity of raw materials used by Neanderthal groups enables us to understand the potential existence of an economy of raw materials related to tool functions: were flint tools reserved for different activities to those made of quartzite, quartz, lydite, ...?

Based on a preliminary overall comparison of the pieces studied which show signs of use (table 63), and with the exception of ophite, activities linked to animal resources predominate, regardless of the type of raw material used. These are followed by the working of wood or of a medium-hard material which may have been wood. This initial result once again highlights the importance of activities related to butchery and for which it is not possible to identify a preference for any one raw material over another. However, at Mauran, only the flint tools (6 in total) show traces of scraping of a medium-hard material of such as wood.

Cutting is the dominant activity in each group of raw materials except for ophite, which was used solely for percussion. The latter action, typically less frequently identified within the *chaîne opératoire* of animal carcass processing, has also been observed for flint, quartz and quartzite tools. In relation to the ophite flakes, in our corpus, these are exclusively comprised of flake cleavers, which would appear to explain this raw material's apparently unique mode of action (percussion). As with cutting in butchery and with percussion, the scraping of hard organic materials (such as bone) was carried out equally with flint, quartz, quartzite and lydite tools.

Although activities related to the procurement and processing of woody materials are in a minority, a higher proportion of quartz and quartzite blanks can be observed as having been used with longitudinal and transverse motions for processing wood, or a material whose hardness is comparable to that of wood (17. 5% of quartz and quartzite tools compared with 11 % of flint tools). It is nevertheless necessary to put this result into perspective, as most of the quartz and quartzite tools which illustrate these activities come from the site of Coudoulous where use-wear analysis of the small number of flint tools was not possible due to their poor state of preservation.

Scraping is the most highly represented activity in the *chaîne opératoire* of gathering and processing wood, whether in relation to flint tools, or quartz and quartzite. Regarding the gathering and processing of a material of medium hardness like wood by means of percussion, this also involved different materials: flint, ophite and quartzite.

The combination of traces of scraping and cutting on the same working edge was observed on 26 edges on flakes and tools made from quartz-quartzite used for butchery, while this was only identified on a single flint piece, a side scraper from Fonseigner, which had been used for working hide. Once again, it is difficult to interpret this difference in terms of an economy of raw materials, given that the objects showing traces of mixed activity all come from a single site, Coudoulous, whose flint industries, regrettably, could not be studied.

In light of these results, it appears difficult to identify, even within the *chaînes opératoires* of butchery and woodworking, any particular link between a raw material type and a specific activity.

Comparison of the activities and the materials worked by flint tools on the one hand, and those identified on all of the other raw materials on the other, does not reveal obvious differences either (figure 240): cutting predominates, followed by scraping. 66 % of the active edges on flint tools were used for cutting, compared with 35 % of those in other raw materials, but this difference between groups of raw materials is eliminated if we include in our comparison the cutting edges having cut in combination with another activity, especially cutting and scraping (67 % compared with 52 %). Percussion is five times less represented amongst the flint tools than those in other raw materials, which is related to the presence in our sample of numerous flake cleavers, made of quartzite and ophite, on which traces of percussion upon hard or medium-hard materials were observed. Finally, piercing is three times more highly represented amongst the flint tools than amongst the other raw materials, even though the proportions remain small (2 % for the quartz and quartzite objects and 6 % for the flint ones). When one looks more closely at the data (Annex 5), it becomes clear that within the industries which revealed traces of piercing ring (Mauran, Les Fieux),

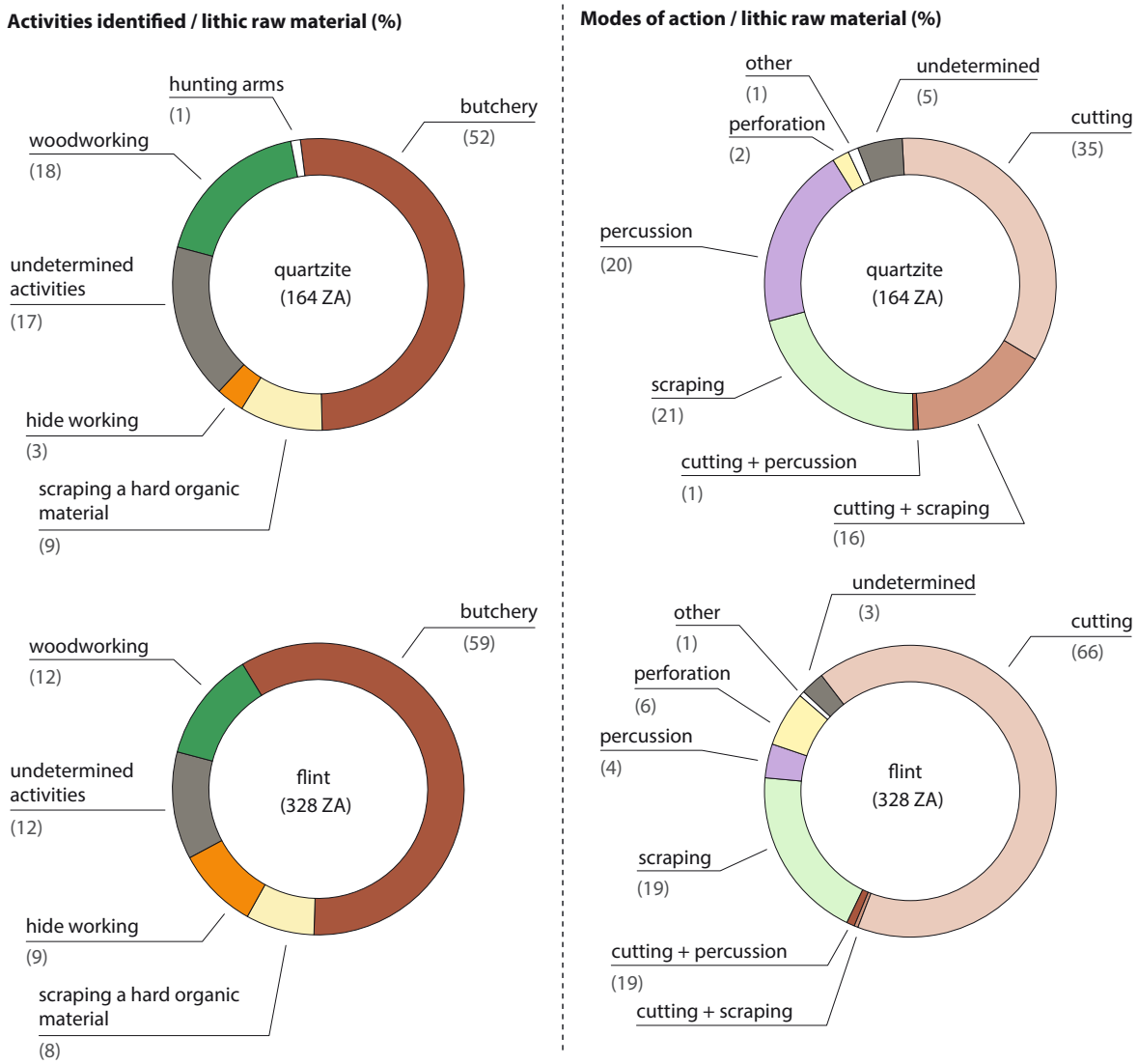


Figure 240 - Illustrations of the proportion of different materials worked and the different modes of action identified on the active zones, according to lithic raw material (flint *versus* other raw materials).

this activity, which is very rare, is represented by tools made of both flint and quartzite. The overall difference in percentage is in fact linked to the identification of numerous flint objects from the site of Payre where quartz and quartzite are absent. It is therefore difficult to decide in favour of a functional economy of raw materials in relation to piercing.

The main difference is to be found in the higher proportion of flint tools reserved for working hides, even though the rate of this activity remains low (9 % for flint and 3 % for other raw materials): 20 flint objects were used to cut hides, as opposed to just one made of quartz or quartzite (table 63). For scraping, the difference is less pronounced, since seven objects are flint, and three are made of quartzite or quartz. Two of them were identified at Coudoulous (cutting and scraping of hide with side scrapers) and one at Grotte du Noisetier (hide scraping with an unmodified flake). Methodologically speaking, while quartz-quartzites display the micro-rounding, polish and striations produced on their edges during this work quite clearly (see Part I, chapter 2.6), the traces visible under a stereomicroscope are relatively slight and may be compared to those produced by the cutting of a soft material such as meat, especially in the context of use over a short period of time. Seeing as our interpretations are principally based on analysis of the macro-traces, it is possible that traces related to the working of hides have been underestimated on raw materials other than flint. We may add that the flint tools used for cutting up hides came from two sites, Chez-Pinaud and Fonseigner, where quartz and quartzite were absent or have not been analyzed (pebble industry at Fonseigner). Moreover, the quartz and quartzite flakes from Coudoulous qualify these remarks since at least three tools were used for the cutting or scraping of hides. The only sites where flint and quartzite flakes were found showing traces of use on both raw materials (Mauran, Les Fieux) have unfortunately not undergone a microscopic scale analysis like the other assemblages studied. Furthermore, evidence of hide working was identified on side scrapers and unmodified flakes made from quartz and/or quartzite found at Axlor, Cueva Morin and El Salt (Lazuén, 2012a; Lazuén, Gonzáles Urquijo, 2014; Rodríguez Rodríguez *et al.*, 2002).

Data from the literature do not easily enable us to address the issue of the economy of raw materials during the Middle Palaeolithic from a functional point of view. Firstly, the assemblages presented which contain different raw materials are extremely rare (Annex 1). In addition, significant differences are not visible within these collections. Overall, the same groups of activities may be identified on the quartz-quartzite industries as much as on those in flint: cutting for butchery, working wood and hide processing are predominant. When examined in detail, the data are difficult to exploit, as they are influenced simultaneously by the sampling methods of the analyses that were carried out (the entire quartzite pebble industry, and a few flints were studied at Romentères, for example), but also possibly by the differential preservation of the various raw materials represented.

B - Flake production methods

In relation to flake industries, a comparison of the use-wear results obtained from, on the one hand, tools made using Discoid debitage (Saint-Césaire, Les Fieux, Mauran, Bayonne PM1) and those made with Levallois debitage on the other (Fonseigner, Bayonne le Prissé PM2) does not demonstrate meaningful differences in terms of the presence and frequency of the modes of use identified. Butchery predominates within both systems of production, while the processing of hides and of a medium-hard material such as wood are also well represented.

Furthermore, it is difficult to exploit the data acquired for industries within which several debitage methods are represented, to discuss a potential relationship between the method used and the use of the object, because not every piece which bears traces of use has necessarily been identified as belonging to a particular production method (e.g. at Chez-Pinaud, see Soressi, 2002).

Data from the literature enable us to make the same observation: each method was capable of responding to the Neanderthals' diverse needs. For example, skinning animals was carried out with tools produced using various debitage methods (Levallois, micro-Levallois, Discoid, Quina, Le Pucheuil, see table 65). The working of hides and of medium-hard materials such as wood are also represented in all of the debitage methods for which a substantial number of objects was studied (the Levallois micro-flakes from La Quebrada only display traces of butchery, but only a preliminary test was carried out on 22 objects). While the various production methods are linked to the procurement and working of animal and woody materials necessary for the Neanderthal people's subsistence (butchery, sourcing and processing of wood, hide working), the tools produced by different methods do not display the same functional properties. In fact, the specific aspects of these activities almost certainly varied from one mode of production to another (dominant modes of action, condition of the worked materials, frequency of resharpening, ...). Unfortunately, due to the imprecision of use-wear interpretations on archaeological tools, we were unable to attain such a degree of precision.

Whether the data were obtained in the context of the PCR on the site of Chez-Pinaud US 06-07, or come from published studies, in the assemblages which include a *chaîne opératoire* of manufacturing bifaces or even of bifacial side scrapers / *hachoirs*, relative specialization of the manufacturing flakes appears to exist, since these are principally or exclusively used for cutting, for butchery and/or working hides (Saint-Amand-les-Eaux, Canolle, Chez-Pinaud US 22, La Cotte de Saint Brelade, tables 58, 65, 69). For the latter activity, identified on the site of Chez-Pinaud US 22, the use-wear traces are probably related to the defleshing of fresh or moist hides, and are observed for the most part on the side scrapers (ten scrapers on manufacturing flakes, compared with one unmodified flake used, Chez-Pinaud US 22). Nevertheless, the manufacturing flakes, unmodified or retouched, are not the only tools to have been used for these activities. Flakes produced by debitage, bifaces and side scrapers other than those on manufacturing flakes also display traces of cutting for butchery. The Quina side scrapers from Chez-Pinaud US 22 were also used for working hides (probably for hide defleshing, using a tangential cut) and for percussion on hard materials such as bone (butchery).

Side scraper retouch and/or resharpening flakes were also sometimes used, as shown by the studies carried out on the industries of Les Tares, La Cotte de Saint Brelade, the Quina Mousterian objects from Chez-Pinaud US 22, Abri du Musée, Axlor and Cueva Morín (table 65). In the industries from Les Tares, Chez-Pinaud US 22 and Abri du Musée, these flakes only bear traces of butchery, while in the case of Axlor and Cueva Morin, the uses were more varied but always non-percussion gestures, and including butchery and the working of wood, plants and fresh hides, with the last of these activities being the best documented.

Finally, a few notching flakes from Saint-Césaire carried traces of use linked to butchery (table 58), but, as these were localized on the butts, they attest to the mode of use of the parent piece from which they came. As the edge in question was unmodified, this observation enables us to demonstrate that notches or denticulates were produced from flakes, at least part of the edges of which were used unretouched for butchery activities. The notch or denticulate thus formed resulted from the resharpening of an unmodified blank used for butchery and may, afterwards, have been used again for this activity, as evidenced by the numerous traces of butchery observed on the notched objects in this assemblage.

C - Tool types

The previous chapters (Part II, chapters 4.2 and 4.3), which focused on the procurement and processing of animal and plant materials, enabled us to note the use of different types of tools for each of the activities identified, regardless of how they were carried out or the material worked, and whether this involved our own data or data from the bibliography (figure 239, table 70). On

the basis of all of the data collected as part of the PCR, it appears that, with the probable exception of perforating hides, identified on just two pseudo-Levallois points (Les Fieux, Mauran), no activity was carried out with a single tool type: cutting activities for butchery attest a large diversity of tools used, as do longitudinal actions on woody materials (table 58).

However, certain activities involved the use of a more restricted number of object types, as seen in the example of percussion on a medium-hard material such as wood, or a hard material like bone, which for the most part involved the use of bifaces and flake cleavers. It therefore appears that a real correlation exists for these activities between the action carried out and the use of tools which were best suited to the goal to be attained (chopping tree trunks or cutting up animal carcasses by percussion). Therefore it was in all likelihood a functional choice (more solid tools for work requiring force), within which a human group's technical traditions could play a role (flake cleavers versus bifaces), in addition to a raw materials economy.

Hide scraping is also concerned here. This was carried out using unmodified flakes with edges that were convex in plan and/or side scrapers. It seems possible to suggest that there was a close link between the morphological properties of the tool edges and their intended functional role.

In this section, we will examine the functional objectives of each tool type, whether unmodified or retouched, so as to bring to light their potential functional specializations. Given the very small numbers of certain tool types, we believed that it was better to exclude them from this approach (four Mousterian points, two Levallois points, two flakes with abrupt and marginal retouch, two triangular flakes – possibly impacted –, one limace, one *bec* and one composite tool). These objects were used for butchery, with the exception of the composite tool, which was used to scrape a medium-hard material such as wood, and one of the Mousterian points, which was used to cut up hide. We invite the reader to consult table 58 for further details. Also not very numerous are the retouched flakes, eight in total, as well as the endscrapers, of which there are five. Furthermore, these exhibit significant morphological variability (e.g. in terms of the position and type of retouch), and therefore are not discussed here either. Finally, data obtained from biface manufacturing flakes and from side scraper or biface resharpening flakes, which were mainly used for cutting during butchery or for the defleshing of hides, were discussed in the previous chapter.

The figures 241-242 are graphs which depict the frequency of the materials worked and the modes of action identified for each type. These provide a quick overview of the available data for the other types of tools.

a - Unmodified flakes and backed knives

Amongst the tools with unretouched cutting edges (aside from the flake cleavers), we have distinguished a number of categories, as their morphological characteristics appear to indicate different functional potentials:

- pseudo-Levallois points, which are sharply pointed by definition and have an unretouched butt and back opposite the point;
- backed knives (cortical and retouched) as well as core-edge flakes, which by definition have a back which is cortical, unretouched or retouched, opposite a cutting edge without a point;
- other unmodified flakes, without backs.

For all of these tools, it appears that the activity group identified is very similar (figure 241), and comparable to that brought to light for all of the active areas (see figure 211). A little over half of the active areas were used in a butchery context, a fifth of them for working a medium-hard material like wood, and the proportions of other activities are low: between 4 and 7 % for hide working and between 3 and 7 % for scraping a hard organic material such as bone (probably for butchery).

Figure 241 - Illustrations of the proportion of different materials identified on the active zones for each type of tool.

The actions themselves (figure 242) are varied, albeit predominated by cutting (between half and two-thirds, if we include the pieces used for both scraping and cutting), related principally to butchery (figures 217-220, 224-225, 227) but also to the cutting of hides (figure 235). Scraping makes up between 19 and 30 % of the working surfaces and edges, and is followed by similar proportions of piercing and percussion. Percussion, most likely linked to a butchery activity, shows a rate of 13 % on backed knives and flakes with core-edge backs (three pieces, from Chez-Pinaud and Saint-Césaire, see figures 229-230), though it is absent from the pseudo-Levallois points and extremely rare on the other flakes (one object). Conversely, piercing represents 17 % of the activities on pseudo-Levallois points while being absent from the backed pieces and rare on other flakes (8 %). Unfortunately, the materials that were perforated are rarely identified, but for two pseudo-Levallois points, one from Les Fieux and the other from Mauran, it may have been hide (figure 236).

Ultimately, the objects with an unretouched edge, which were used according to very varied modes of operation (figure 239), were principally employed for cutting (meat, hide), secondarily for scraping (of a medium-hard material like wood, or hard such as bone, or hide), and to a lesser extent, based on certain functional characteristics of the tools (the presence of a back which made prehension easier / the presence of a naturally pointed part), for other modes of action such as percussion (butchery) and piercing (hide, indeterminate material). Earlier use-wear studies, whose results are available in the literature (see table 59) also suggest a very large range of uses for unmodified flakes. It is also worth noting that unretouched Levallois flakes were used preferentially for percussion upon hard organic materials such as carcasses, at Hermies (Vallin *et al.*, 2006; Claud *in* Vallin [ed.], in prep.).

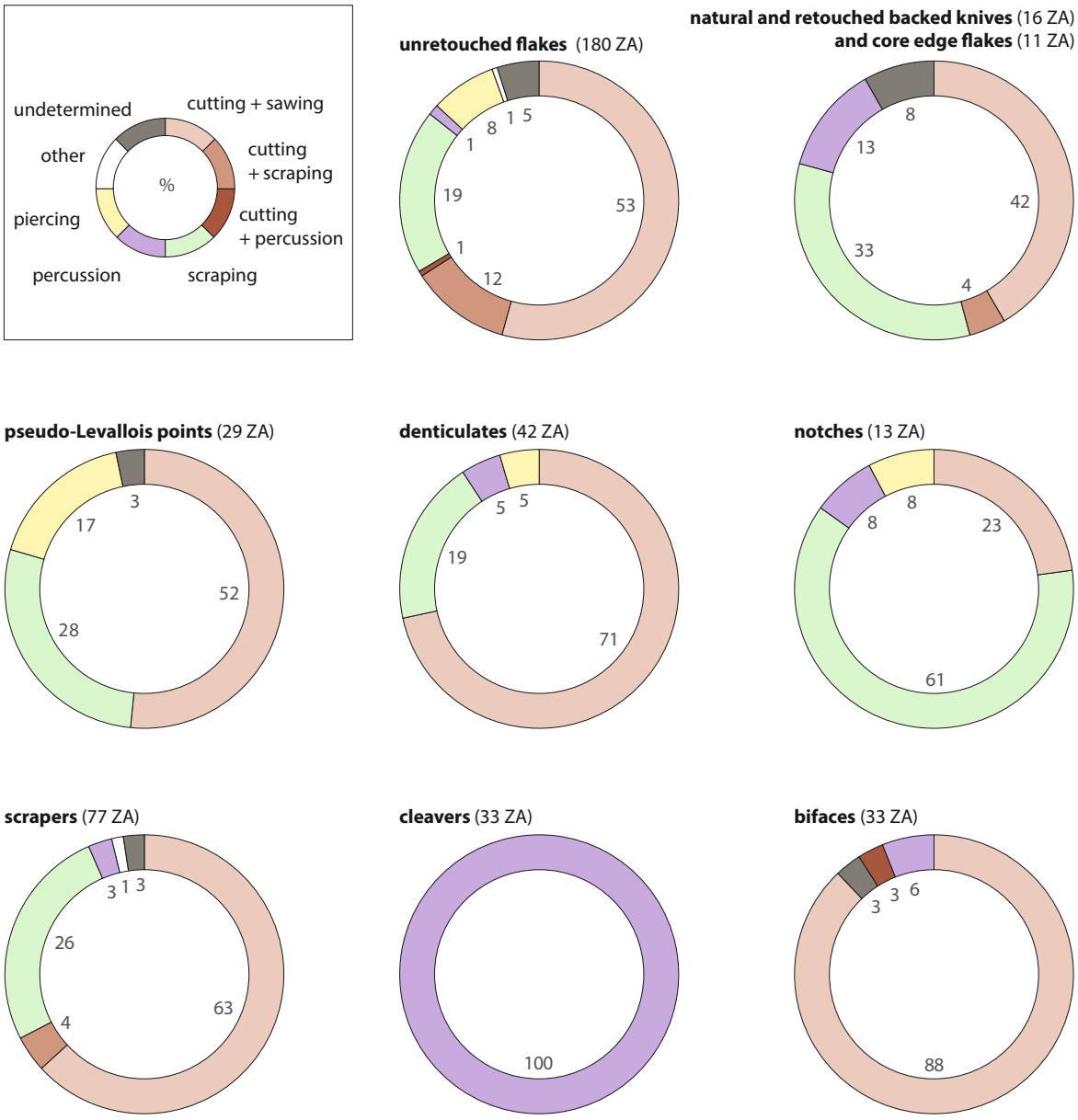


Figure 242 - Illustrations of the proportion of the different modes of action identified for the active zones for each type of tool.

Even though they are unmodified blanks, but unlike ordinary flakes or those with a cortical back, core edge flakes and more specifically pseudo-Levallois points produced using a Discoid debitage *sensu stricto* (Mourre, 2003a), for example at Mauran or Les Fieux, are predetermined tools in the same way as Levallois flakes are. In fact, they represent the essential aim of stone knapping. While the large functional diversity of the ordinary unmodified flakes may reflect opportunistic behaviour, the absence of a functional specialization of the pseudo-Levallois points along with their morpho-functional characteristics attests to the influence of the knappers' technical traditions when making them.

b - Denticulates

As we saw within our reference collection (see Part I, chapter 2.7), a high proportion (39 %) of denticulates did not show characteristic macroscopic traces of use. Amongst these objects, tools reserved for butchery were the most numerous (66 % of the denticulates used in butchery did not show any macroscopic use-wear traces, compared with 21 % of objects used on wood and 22 % for hide working). The proportion of archaeological denticulates which can be interpreted in terms of function cannot avoid being underestimated in the assemblages which could not be examined microscopically, and, even more specifically, that of the quartzite denticulates used for butchery.

Thus, while we may have expected a small proportion of archaeological denticulates used in butchery, the use-wear analysis results demonstrate that two-thirds of the denticulates which show use-wear traces were used in butchery, principally for cutting (27 active zones out of 29, figures 219[b,e], 225-227d, 241, table 58). Cutting is, as a result, the predominant mode of operation within this collection of tools (71 %, figure 242). The use of denticulates for butchery was identified on all of the sites where denticulates with use-wear were found. The numbers are higher at the sites of Saint-Césaire, on flint denticulates with micro-, medium or macro-denticulation, as well as at the site of Mauran, on flint and quartzite denticulates, mainly with medium and micro-denticulation. The use of numerous denticulates for butchery was brought to light at Abric Romaní (Martinez-Molina, 2005), and a denticulate was used for this activity in layer XX at Grotta Breuil (Lemorini, 1992).

Working a medium-hard material such as wood, by scraping or with a longitudinal gesture (sawing) represents 17 % of the working edges (figures 214-215, 241). At Mauran, while flint and quartzite denticulates were used for butchery, those used for woodworking were mainly made of flint, with only one quartzite piece having been used to work wood. For scraping, denticulates with macro-denticulation, and more rarely medium denticulation, were used. Sawing was carried out using denticulates with medium denticulation.

The denticulates used for scraping hard materials such as bone, perhaps in a butchery context, represent 12 % of the working edges (figure 231-232, 241). Made of both flint and quartzite, but all with macro-denticulation, the majority of them come from the site of Les Fieux. To this we may add two denticulates with macro-denticulation which come from Les Fieux and Saint-Césaire which were used to work a hard organic material by means of percussion (probably for the processing of a carcass). They have a thick back, which made prehension easier, opposite the working edge (a cortical back at Saint-Césaire and a core edgeback at Les Fieux, figure 230).

Lastly, a very small number of denticulates show traces of piercing (of an indeterminate material: a flint denticulate from Mauran and a quartzite denticulate from Les Fieux, figure 214). None of the denticulates in our corpus could be associated with the working of hide. However, it seems that at Abric Romaní, some denticulates show traces of scraping fresh hides (Martínez-Molina, 2005). Their working edges, concave or denticulated, raise the question of the precise function of these objects. Scraping is in fact a rather inefficient means of removing flesh from fresh hides, and it

therefore seems unlikely that these tools would have been used during this activity. Furthermore, for each of the stages of working a hide by scraping, the presence of denticulates on an edge significantly increases the risk of accidentally piercing the hide, which would appear to make denticulates unsuitable for this activity (see Part I, chapter 4.3.B.c).

Use-wear traces are located on the denticulated edges, except in the case of one denticulate from Saint-Césaire, which has traces on an unretouched part of its edge. These were intersected by the production of the denticulation, which was most likely carried out as part of a resharpening of the edge.

Therefore, contrary to functional hypotheses put forward by others (Bordes, 1961a; Kantman, 1970a), and to the results of earlier studies (Beyries, 1987; Anderson, 1987), the denticulates in our collection were not principally used for sawing wood, and this activity was in fact very much in the minority. The denticulates were predominantly used in butchery for cutting activities and, to a lesser extent, scraping bone, followed by scraping and sawing a medium-hard material. While all types of denticulates revealed use-wear, longitudinal action was mainly identified on denticulates with medium and micro-denticulation, and in rare cases, on tools with macro-denticulation (principally at Saint-Césaire), while transverse actions were identified on denticulates with macro-denticulation and on a few pieces with medium denticulation.

c - Notches

Notches in our corpus which show use-wear traces are rare and for the most part Clactonian (12 notched tools out of 13), with only one, from Mauran, having been retouched (table 58). This result goes hand in hand with the almost total absence of retouched notches in the assemblages studied. For these working edges, the range of activities and the principal modes of operation are clearly distinct from those described for the unmodified flakes and the denticulates, as here we observe the predominance of scraping (figure 242), mainly of a hard organic material such as bone (possibly for butchery). This activity represents half of the working edges (figures 231-232, 241). A Clactonian notch which was used for scraping bone was also found at Grotta Breuil (Lemorini, 1992). Three working edges were probably used in butchery, two for cutting (one flint notch from Les Fieux and one quartzite notch from Mauran) and one for percussion (flint, from Saint-Césaire, figure 230[d]). The working edge, used for percussion, is opposite an edge which has perpendicular crushing, creating a sort of backed edge.

The working of a medium-hard material such as wood is poorly represented amongst the notches, with only one object (out of 13), a flint notch from Les Fieux, having been used to scrape this material.

None of the notches in our corpus presented traces clearly linked to hide working, whether for cutting, scraping or perforating. The data from published studies nevertheless enable a more nuanced view, as two assemblages revealed evidence for hide working on notches. The first study is that carried out at Riencourt-lès-Bapaume (Beyries, 1993), which brought to light the use of retouched notches for scraping dried hides, which had probably been placed on a hard and convex surface. The second study was carried out on the assemblage from Grotta Breuil. In layer 6, a Clactonian notch was used for cutting, with an indeterminate transverse movement on dried hide. Another notch, of an unspecified type, was used to cut and scrape a hide that was not fresh. Polish caused by cutting or scraping hide was also present on a notche from layer 3 (Lemorini, 2000).

While the idea of a specialization of notches and denticulates for woodworking which was put forward in the 1980-1990s (Beyries, 1987: 121) is called into question by our results, we can however propose the notion of a tendency towards specialization of tools with Clactonian notches, simple

notches, or denticulates with macro-denticulation. Indeed, although the number of notched pieces showing signs of use remains relatively low, these types of notches were mainly used with a transverse movement (scraping of medium-hard and hard materials). Denticulates with micro-denticulation, on the other hand, were used for cutting. Denticulates with medium denticulation were also used principally for cutting, though a few of these show traces of scraping. In light of our results, it appears that a correlation can be shown between the type of activity of the notched tools and the type of denticulation, thus reflecting a morphometric adaptation of the working edge to the action performed.

However, we know that butchery or scraping a medium to hard material can be carried out using simple unretouched edges. Notching or denticulation are therefore not essential and, in theory, do not add efficiency to the cutting edge. It is worth highlighting that at Mauran, Les Fieux and Saint-Césaire, notches and denticulates were produced mainly on backed blanks, points or flakes, which were the principal objectives of debitage. In these assemblages, side scrapers are rare or even absent, and the denticulates and notched tools only represent a small proportion of the tools. They were therefore not the main objectives of production (Thiébaut *et al.*, 2009a, 2011). This technical aspect, in correlation with the absence of bone retouchers and of side scrapers retouched using soft hammers on these sites, is significant in terms of the technical traditions of these groups of people.

d - Side scrapers

With more than half of the working edges used for butchery (100 % for side scrapers on biface manufacturing flakes, table 58) and 63 % of them having been used for cutting, the range of activities and the modes of action identified for side scrapers seem at first to be relatively similar to those observed for all working edges on unmodified flakes (figures 211, 241-242).

However, the most highly represented activity after butchery is not the working of a medium-hard material such as wood, but rather hide working, which accounts for almost a quarter of the working edges present on the side scrapers. Cutting hides is more frequent than scraping (11 pieces compared to 6, with the latter set of objects coming from just two sites: Fonseigner and Coudoulous), and the working of dry hides is less common than that of hides that were fresh or in an intermediate state. A single side scraper shows signs of having been used both for cutting and scraping a dry hide on the same edge (Fonseigner, figure 237).

Working edges are systematically convex, whether these were simple lateral edges, double, convergent or even transverse (figures 235, 237). Evidence for the resharpening of side scrapers used for cutting hide is present on two examples from Chez-Pinaud, probably used for defleshing hides that were fresh or in an intermediate state, which bear traces of use on a small retouched area of the working edge, while the rest of the side scraper does not appear to have been (re)used.

It is worth noting that the traces of scraping, identified at Fonseigner on five side scrapers, were in fact observed on the unretouched edges of four of the tools. The edge retouched to form the side scraper shows signs of cutting in a butchery context, or else does not have any evidence of use (figure 237).

Working a medium-hard material such as wood only accounts for 10 % (8 objects). For this material, tools used for scraping are the most numerous (6 out of 8, table 58).

Lastly, 9 % of the working edges were used to scrape a hard material such as bone (possibly during butchery).

Piercing is absent and percussion rare. The latter was identified on two flint pieces from Chez-Pinaud. The first of these is a side scraper with rather irregular retouch, whose unretouched edge shows traces of use for percussion on a medium-hard material such as wood. The opposite edge,

retouched to form a side scraper, did not show any use-wear traces (see figure 213). Even though the retouched edge is relatively sharp, the morphology of this side scraper and the function of the unretouched edge resemble that of a knife with a retouched back. The second object, a convex side scraper, was used on the retouched scraper edge, to strike a medium-hard material such as a carcass (most likely in a butchery context, figure 229[c]). Several publications also mention the use of side scrapers for percussion, in particular for chopping hard materials, probably as part of butchery, such as the large side scraper / *hachoir* from Fond-des-Blanchards and several Quina side scrapers from Chez-Pinaud (US 22) (Claud *et al.*, 2012; Lhomme *et al.*, 2007). Lastly, V. Rots also suggests that a *déjeté* side scraper and a double side scraper from Biache-Saint-Vaast were hafted and used for percussion on wood (Rots, 2013).

Ultimately, despite a very wide range of activities having been observed for side scrapers, both during our study and in published studies, with variability seen within and between sites, the principal context for the use of side scrapers appears to be butchery, mainly for cutting and less frequently for percussion, followed by hide working, for cutting and scraping (see in particular table 69). While the side scrapers were used for butchery in the same way as other tools (flakes, denticulates and bifaces with converging edges, see below), a strong correlation appears to exist between hide working and the production of side scrapers with a convex and very regular working edge, whose morpho-functional properties were truly transformed when compared with the original working edge. The morphology of certain side scrapers was very likely to have been desired and developed right from the beginning of the tool's use-life, as is probably the case of the side scrapers on side scrapers manufacturing flakes from US 22 at Chez-Pinaud, where the flakes were only very rarely used unmodified for working hide (a single example, compared with nine for butchery). However, this idea must not make us forget that unretouched working edges were sometimes used for cutting or scraping hides of various states of freshness, and that side scrapers probably underwent multiple resharpenings. Regarding the side scrapers used for butchery, it is difficult to distinguish those which were conceived as they were found, from those for which the presence of retouch is due to resharpening.

e - Flake cleavers

All of the flake cleavers studied which showed use-wear traces were used for percussion (figure 242). While this result undoubtedly indicates that these tools were put to a specific use, it is important to point out that this rate of 100 % percussion may be an overestimation due to the poorer preservation of the use-wear traces from actions whereby the tool is used in non-percussive activities, whether this be scraping or cutting, as a result of a relatively mediocre state of preservation of the analyzed assemblages (see table 46). Flake cleavers may therefore have been used for other activities, as their morphological variability, especially in terms of edge delineation, would tend to suggest. Indeed, certain flake cleavers, such as those with two edges delineation, appear to be more suited to other uses, such as cutting meat, than to chopping actions against medium-hard or hard materials (see Part I, chapter 2.9). Future research on better-preserved flake cleavers will perhaps provide a more accurate and nuanced vision of the technical function of these tools.

However, no other tool type has such a high number of examples having been used for percussion, even the unmodified flakes (5 pieces out of 207 analyzed) or the side scrapers (2 out of 78), which attests to a distinctive function for the flake cleavers.

They were used for processing carcasses, as well as for procuring medium-hard materials such as wood (figures 212, 228-229, 241). Almost half of the flake cleavers could not be linked with one activity, due to the morphological similarity of traces associated with woodworking and those

associated with processing carcasses by percussion (see Part I, chapter 2.9). Given their considerable morphometric variability, we were unable to bring to light any particular links between the dimensions of the flake cleavers, their type or even their raw material, and the activity for which they were used.

It is important to bear in mind that, despite the absence of traces related to hafting, the intensity of wear present on the working edges would seem to suggest the necessity of such a measure.

The data available from the literature, though extremely rare in relation to flake cleavers, are coherent with our observations, as percussion is a recurrent mode of action for the objects examined (Utrilla, Mazo, 1996; Rios-Garaizar, 2010).

These data form an argument in favour of the functional hypothesis (Freeman, 1969-1970) to explain flake cleaver production in the Vasco-Cantabrian region, where they were manufactured to perform large-scale percussion activities. However, the fact that different materials were worked adds nuance to this theory. The practice of these activities, evidence of which is recurrent in the Vasconian Mousterian but unusual in the other Mousterian industries of South-West France, reflects the use of specific techniques for exploiting plant and animal resources. Other technical choices could have been made, for example the burning of the base of trunks for tree-felling (Noël, Bocquet, 1987: 159), or the breaking down of carcasses solely by cutting or by breaking the ribs by hand (through flexion). These techniques were most likely linked to a specific tradition, but it is important to consider the possible influence of the environment, as it could have favoured certain exploitation methods. The climate, the quality and the quantity of wood available (dead or standing) may have determined the techniques used for cutting down and processing this resource (Théry-Parisot, 2001). Similarly, the type of fauna and the seasonal behaviour of animal species can encourage the use of certain hunting techniques and different modes of carcass exploitation, which are in turn related to the nutritional needs of human groups. The influence of the overall environment is difficult to identify due to the scarcity of absolute dates, which nevertheless place some of these industries in marine isotope stage 3. Other sites also attest the presence of flake cleaver and biface industries associated with marine isotope stage 5, according to relative chronology data (Álvarez-Alonso, 2014). The faunal spectra, which reveal high numbers of deer and the presence of bovids, horse and rhinoceros, provide evidence, according to some authors, of a temperate climate and the presence of forest cover (Passemard, 1936; Cabrera *et al*., 2005). Pollen, sedimentology and palaeoclimatology studies have enabled Vasconian levels from El Castillo, Cueva Morin and El Pendo to be attributed to periods which oscillated between temperate and dry-cold climates (Dari, Renault- Miskovsky, 2001; Butzer, 1981; Sanchez-Goñi, D'errico, 2005; Iriarte *et al*., 2005). While the vegetation cover was present and pioneer taxa, in particular birch, were predominant, it was also associated with an open landscape. The faunal taxa identified remain ubiquist, as they show the ability to adapt to different climates and environments. Thus, wood resources were present in the environment. The high numbers of deer, but also the presence of certain species such as bison, horse or Merck's rhinoceros may also have encouraged specific exploitation methods, in terms of the dimensions of the carcasses. However, different choices were made by other groups when breaking down the carcasses of large herbivores, which did not involve the use of edged tools for percussion, or else involved the use of tools for percussion, but which show less intensive use-wear traces in comparison with those observed on flake cleavers, most likely indicating the use of less force (objects held with bare hands, less brutal contact with the bones, for disarticulation or flesh removal, versus flake cleavers which were hafted and used for breaking).

Flake cleavers thus appear to have held a particular functional status related to the primary acquisition of plant resources (felling) or to large-scale butchering activities using percussion. The considerable spatio-temporal segmentation of their manufacture – they are never made on the sites where they are found (Deschamps, 2014) – appears to give them high mobility, even though

the properties of their unretouched working edge do not endow them with as much longevity as bifaces and therefore does not enable them to travel over the same distances (Geneste, 1985; Turq, 2000; Faivre, 2006).

Moreover, the diversity of raw materials – with the exception of flint – with which they were made (ophite, quartzite, schist, limestone, sandstone) does not allow us to determine the exact provenance of the materials used. These choices of raw materials associated with their manufacture nevertheless imply an economy of raw materials which seems to be independent of the level of availability of flint. Flake cleavers, made of quartzite and ophite, were found at Bayonne le Prissé, alongside bifaces made from good quality flint which was available locally and in large quantities. Flake cleavers are also the only objects made using these grainy materials to have been found in these assemblages. It is likely that the choice of raw materials was linked to a search for very resistant materials. We therefore appear to have identified a positive choice from very diverse mineral resources, rather than a constrained choice in a restrictive environment. The use of grainy materials for the manufacture of flake cleavers therefore appears to be related to functional objectives, as opposed to determinist constraints imposed by the available mineral resources.

f - Bifaces

These tools bear traces which indicate a very high rate of use for cutting as part of butchery (76 %, figure 241). Bifaces showing traces from cutting hides (12 %) could in fact have been used during butchery, for skinning. As previously discussed (see Part II, chapter 2.3), the low level of rounding, the strong brightness of the polish (fresh or wet hide), the presence of scars which may indicate contact with bone, along with the fact the other edge of one biface showed signs of butchery, are all arguments in favour of this interpretation. Cutting soft to medium-hard flesh and/or skin materials in a butchery context would therefore account for a total of 88 % of working edges.

One biface was used to scrape a hard organic material such as bone, while two bifaces, or 6 %, show traces of percussion on a medium-hard material such as wood (figures 241-242, table 58).

Despite the very high frequency of traces of cutting from a butchery context, it was possible to identify a relationship between the morphology of the bifaces and their functions (Claud, 2008 2012, 2014b): the bifaces with convergent edges were used (regardless of their level of resharpening, as long as this preserved their initial functional properties, i.e, at least one cutting edge or a sharp extremity) for butchery, while the two bifaces with a transverse cutting edge from La Graulet show traces which indicate use for percussion on medium-hard materials such as wood (figure 213). Another biface from La Conne de Bergerac, with the same morphology, may also have been used in this way, though with less certitude (figure 213). The hafting of these tools for use appears likely, in light of the mode of action and the morphology of the bifaces, though no direct evidence could be identified. A handle would have allowed a more comfortable prehension and greater force to be exerted, because of the addition of a lever and an increase in weight, especially considering that these bifaces are relatively light (200 g on average). Their bases are quite thin, finely retouched and very regular, which suggests to us that these tools may have been used with a handle attached to the proximal end. Conversely, the frequency of bases with cortex remaining and the often considerable thickness of the bases on bifaces used for butchery, coupled with a higher efficiency amongst experimental pieces held with bare hands for this activity, tend to suggest that bifaces used as butchering knives would have been hand-held.

Lastly, a single biface which shows signs of scraping (on hard organic material), from Chez-Pinaud, is characterized by a large lateral tranchet blow on the cutting edge, which covers half of the lateral edge (figure 231[b]). This removal enabled the delineation and the profile of the working edge to be adjusted, rendering it more suitable for scraping hard materials. This type of removal

has been observed on a small number of bifaces from the same site, used for cutting during butchery, but on these pieces, it was less invasive and/or interrupted by later retouches.

The inclusion of bifaces used on mineral materials in our study broadens the spectrum of activities carried out with this type of object (see Part II, chapter 2), principally at Chez-Pinaud, Fonseigner and Bayonne le Prissé.

Two bifaces from Chez-Pinaud had unusual morphologies (one, a broken preform which was reused as a denticulate for butchery, see figure 222[d], the other, an exhausted biface), show wear associated with scraping a hard mineral material. The second biface bears red residues, whose distribution, in the hollows at the termination of the scars present on the object, probably attests to a functional origin (Claud, 2008: 370). The hypothesis of working a colouring material may be suggested, but will of course require chemical analyses, which will need to carried out in the future.

The principal traces left by mineral materials on the bifaces were of percussion and friction. Traces of percussion were identified on the edges and the surfaces of numerous bifaces (13 active areas, tables 47-48, Claud, 2008; Thiébaut *et al.*, 2010b). Traces of friction against a hard abrasive mineral material were observed on the surfaces of bifaces, and sometimes associated with evidence of percussion (12 active areas).

Traces of percussion on biface edges were often observed on the lateral working edges of exhausted or heavily reduced bifaces, which may suggest a reuse of these tools 'at the end of their use-life' for another activity. However, in some cases, these use-wear traces have also been observed on the bases of bifaces which were still in use (Bayonne le Prissé, Les Bessinaudes). Comparison with experimental use-wear traces (Claud, 2008; Claud *et al.*, 2010; Thiébaut *et al.*, 2010b) from different activities (blank retouching, voluntary crushing of the edges for prehension, use as a wedge for splitting wood, grinding-up or crushing of ochre on a stone anvil, shaping or maintenance of a stone hammer) demonstrates that these objects were most likely used in the retouching of denticulates (Claud, 2008).

Traces of percussion and friction on the surfaces of bifaces are present on examples at various stages of reduction, from a "just shaped and retouched" state, to a very reduced state, but which was still in use for butchery, or exhausted. These use-wear traces therefore formed at different moments in the use-life of the biface. This observation fits with the fact that the two types of wear have also been found on the upper faces of several biface manufacturing and retouching flakes found at Chez-Pinaud and Grotte du Noisetier. The intersection of these traces by later removals on a large number of bifaces makes it difficult to describe them in terms of distribution and location. The morphology and distribution of the traces of percussion without associated friction may relate to the use of the bifaces as hammerstones for retouch, as has been demonstrated by several experiments (Claud, 2008; Claud *et al.*, 2010; Thiébaut *et al.*, 2010b). Evidence for friction takes the form of heavy rounding and large numbers of striations, whose exact origin could not be identified during an initial study (Claud, 2008). They may be the result of the bifaces being used as strike-a-lights, by means of percussion with a tangential motion on a piece of pyrite or marcasite, as suggested by both the efficiency of such an activity for producing sparks, and the nature of the wear this causes, combining impact cracks and striations (Sorensen, Claud, 2016; Sorensen *et al.*, 2018).

Bifaces, depending on their morphological characteristics, were therefore predominantly used to fulfil two distinct requirements relating to animal and plant materials: cutting up carcasses, for the vast majority of examples, and processing wood through percussion. Given the very mobile status of bifaces (Geneste, 1985; Turq, 2000; Faivre, 2006), which were transported by Neanderthals when they traveled, we can put forward the hypothesis that these tools were employed for procurement activities, or during the initial stages of processing organic materials, either animal or plant: primary butchery of carcasses, tree-felling or cutting up wood, probably during supplies procurement potentially linked to other needs such as the sourcing of stone suitable for knapping

(Claud, 2008, 2012). During such activities, they could also have served as hammerstones, or as strike-a-lights, without the cutting properties of their edges being affected. Once back on residential sites, the bifaces could have again been used for butchery, in combination with other tools such as side scrapers, unmodified flakes or denticulates, but they are unlikely to have been used for working hides, or for finer woodworking, at least not in similar proportions to other tools.

If we disregard the data obtained by use-wear studies carried out in the 1980s-1990s, for which a certain number of methodological and taphonomic issues may have, in our opinion, led to problems in interpretation (see Part II, chapters 4.1 and 4.2.F), only a small number of studies enable us to make comparisons with our results. Firstly, data obtained on the bifaces from Lichtenberg, Sesselfelsgrotte, Saint-Amand-les-Eaux, Bayonne Jupiter, Bouts des Vergnes, Canolle and Latrote (see table 65), support our own observations as they indicate a use of these tools predominantly for cutting soft to medium-hard flesh and/or skin materials, therefore broadly for butchery. Secondly, in parallel with the use of the edges, traces of percussion on the bases and more often on the surfaces, at times associated with signs of friction, show that these bifaces were also used for other activities, on stone, for example as hammers or strike-a-lights (Sorensen, Claud, 2016; Sorensen *et al.*, 2018). Finally, it is interesting to note that traces from use for percussion on wood were also identified on bifaces, bifacial tools or flakes with bifacial retouch and a transverse edge, from Sesselfelsgrotte (Rots, 2009) and Biache-Saint-Vaast (Rots, 2013). Moreover, certain bifaces with a transverse distal edge and a cortical base from Bayonne Jupiter and Les Bessinaudes show scarring which indicates their use for percussion on hard organic materials, probably during butchery (Colonge *et al.*, 2015; Brenet *et al.*, 2016; Chadelle *et al.*, in prep.). These observations therefore suggest that bifaces with a transverse distal edge do indeed form a distinct morpho-functional group, characterized by its mode of action (percussion), and not by a strict function, i.e., percussion on a medium-hard material such as wood. In contrast with the bifaces from La Graulet and Sesselfelsgrotte, the thick cortical bases indicate prehension with bare hands. Finally, a biface from Bout des Vergnes, which has a sharp right lateral edge adjacent to a transverse distal edge, was used for cutting during butchery, on the lateral edge (Ihuel [ed.], in prep.), and not for percussion on its distal edge. It should be noted that the distal edge was produced by a transverse tranchet blow, and that it is extremely sharp and fragile. It was thus not retouched by bifacial removals, unlike the distal edges of the bifaces from La Graulet, Bayonne Jupiter and Les Bessinaudes, which, as we have seen, were all used for percussion. It therefore seems, unsurprisingly, that even within the bifaces with a transverse edge, technological and morphological variants may have influenced modes of function. It will therefore be necessary to study them in greater detail in future use-wear analyses and synthesis.

D - Synthesis

Following this research, we are in a position to offer some answers to the questions raised about the potential links between raw materials, the tools used and the activities carried out on the sites studied:

- based on data from the PCR, as well as those available in the literature, no correlation can be clearly identified between a raw material type and a specific activity, a worked material or even a precise mode of operation, aside from the site of Mauran, where only flint tools were used to scrape a medium-hard material such as wood;
- heavier tools, mainly represented by flake cleavers and bifaces with a transverse edge, were used for percussion, for the procurement of woody materials and for processing carcasses;
- a few side scrapers and unmodified flakes, large in size and/or with a back suited to prehension (cortical, retouched, core edge type) were also used for percussion;

- bifaces with convergent cutting edges were, aside from a very small number of exceptions, used for cutting during butchery and, in parallel, may also have been used as hammers or strike-a-lights;
- the rest of the toolkit (various unmodified flakes, side scrapers, denticulates) were for the most part used for activities which did not involve percussion, mainly for cutting in a butchery context;
- side scrapers, in addition to being used for butchery and to a lesser extent for working a medium-hard material, set themselves apart from the other tools by their relatively high rate of working edges, unmodified or retouched, dedicated to working hides, by cutting or scraping. The Quina bifacial side scraper manufacturing flakes (Claud *et al.*, 2012) used for working hide (defleshing using a tangential motion) were almost all retouched to form side scrapers. This retouching probably served to create a working edge which was better suited to the activity to be carried out (i.e. convex and regular);
- finally, Clactonian notches were used preferentially in a non-percussive transverse motion which did not involve percussion (scraping), thus giving them a relative functional specialization.

Cutting in the context of butchery and the working of a medium-hard material like wood using motions not involving percussion were also carried out with a large diversity of tools, including biface manufacturing flakes or side scraper retouch flakes, either unmodified or retouched to form side scrapers (figure 239). These activities do not therefore appear to have influenced lithic production to favour a particular type of tool. Nevertheless, we may be missing some of the information, due to the inaccuracy of certain traceological interpretations, which, for example, do not enable us to reach the specific processing stage (longitudinal motions can correspond to sawing or grooving, transverse motions can be the result of bark stripping or shaping, and butchery tools can correspond to different stages of the activity: defleshing, skin removal, disarticulation, ...).

The scraping of hard organic materials (butchery and/or preparation of the surface of bones for breakage, preparation of retouchers, but also potential scraping of very hard woods, see Part II, chapters 2 et 4.3.B.d) was also identified on various tools, but it is more highly represented on the notched tools (figure 241). Many of these were found at Les Fieux, where this behaviour may have been linked to an intensive extraction of bone marrow.

Hide working appears to have been closely linked to the reuse of side scrapers with convex edges, even though unmodified flakes or the unretouched edges of side scrapers, also convex in shape, were also used for this activity.

Similarly, percussion on a medium-hard material such as wood, or hard like bone, were related to the production of quartzite and ophite flake cleavers – in the Vasco-Cantabrian region – and of flint bifaces with transverse edges.

It thus seems possible to identify the influence of functional needs on the technical choices made by knappers in order to produce tools for working hide and for use in percussion, while for other activities, this factor does not appear to be decisive (based on our data, though these are not sufficiently accurate). Therefore, with the exception of the production of heavy tools such as flake cleavers and certain transverse edge bifaces used for a specific function (percussion), no other activity appears to have led to the application of a particular production technique (biface manufacturing, Discoid debitage *sensu stricto*, Levallois debitage). The debitage and manufacturing methods implemented by Neanderthals for producing tools were therefore essentially the result of technical knowledge and traditions held by groups of people. In relation to the bifaces and flake cleavers, while the decision to produce one or the other to fulfill seemingly similar functional requirements may have been partly influenced by the available raw materials (flint versus quartzite or cinerite), the fact remains that their manufacture is evidence for differences in technical knowledge.

5 - Site functions and human group mobility

(C. Thiébaut, É. Claud, M. Deschamps, M. Brenet, D. Colonge, S. Costamagno, V. Mourre, M.-S. Soulier)

The means of procurement and processing of animal and plant materials implemented by Neanderthals are inextricably linked to the settlement strategies of their territories. These can be understood by identifying the functions of sites occupied by human groups and their potential complementarity. The inherent limitations of the sources (the archaeological sites) and the available information (the degree of completeness of the assemblages, the contemporaneity of the sites studied) for the period we are investigating do not enable us to put forward a pattern of settlement of a territory by a specific human group. In this chapter, we will present various functional interpretations of the sites in our corpus. On the basis of these, we will suggest mobility models for the human groups in question.

On the basis of previous techno-economic and zooarchaeological studies, site functions were suggested for certain archaeological contexts within our corpus. We propose to enhance these initial functional interpretations with the results obtained through lithic use-wear analysis and the study of cutmarks on bone remains (table 71). The length of sites can, as a first approach, be assessed on the basis of the models proposed by Kuhn (1995) regarding the means of procuring raw materials (*provisioning individuals* versus *provisioning places*). *Provisioning individuals* are characterized by an anticipation of needs, whereby unmodified or retouched tools are brought to sites. The settlements would therefore have been short-term and the abandoned tools quite diverse and often resharpened or recycled. Conversely, *provisioning places* involved bringing partly preformed blocks or cores to sites and the presence of various elements of a single *chaîne opératoire* for the production of tools, which thus indicates that these were longer-term settlements. Regarding the animal bone remains, site functions can be determined based on the specific skeletal elements present, the frequency of traces of cutting and intentional breakage on bones but also evidence for carnivores in some cases (open air sites) and the slaughtering seasons identified. These data, correlated with the potential presence of hearths, a structuration of the settlement or a large diversity of activities (identified by lithic use-wear analysis or revealed by faunal remains) all enable the functional interpretations of sites to be refined.

Modeling the settlement strategies of the nomadic peoples of prehistory is a central issue in prehistoric research. Prehistorians draw mainly on the works of L. R. Binford (1980) which came out of his ethnographic observations of the Nunamiut peoples in Alaska and the Bushmen of the Kalahari. The '*foragers* versus *collectors*' model focuses on hunter-gatherer mobility whereby *foragers* and *collectors* are two extremes of a continuum. In this model, *foragers* practise a mobility referred to as residential. Their organisation involves moving their base camps frequently. It is a subsistence strategy based on moving towards resources. In this model, resources are not stored, and the number of residential camp moves in an annual cycle can be very variable. This economic organization is to be found in the ecological environments of equatorial forests in particular, and reveals a rather flexible mobility of the residential camps. This residential mobility may be supplemented with trips made by smaller groups in order to procure certain resources. *Foragers* therefore used temporary camps for specialized activities. *Collectors*, on the other hand, change residential camps less frequently and remain more stable during part of the year. They store resources, and exploitation of resources is carried out by small groups which range out from the residential site. One of the principal differences is that their specialized activities are planned and organized with a precise goal in mind, relating to the exploitation of specific resources. This organization leads to the existence of transit camps and specialized sites. Resources are then brought back to the residential camp. For L. R. Binford, these two models of economic organization and mobility within a territory are highly dependent on climatic conditions and are not unique models which may be applied to the letter.

	Abri Olha I	Abri Olha II	Bayonne le Prissé (PM1)	Bayonne le Prissé (PM2)	Chez-Pinaud (US 06/07)	Combe-Brune 2	Coudoulous 4	El Castillo (layer alpha)	Fonseigner	Gatzarria	La Caune de Bergerac 3	La Graulet 3	Grotte du Noisetier	Les Fieux	Les Pradelles	Mauran	Payre	Saint-Césaire (level Egpf)
Faunal remains	X	X			X			X		X			X	X			X	X
Surface preservation					bad		bad						good	bad	good	bad	bad	good
Detailed description of cutmarks					no		yes						-	yes	-	incom-plete	no	no
Cut marks report					no		no						yes	no	yes	incom-plete	no	incom-plete
Hunting impact traces					no		no						no	no	no	no	?	?
Skinning					?		X?						X	X	X	X		?
Evisceration					?									X				?
Fleshing					?		X						X	X	X	X	X	X
Tongue removal					?									X	X			?
Disarticulation with cutting tools					?		X						X		X	X?	X	?
Disarticulation by percussion																		
Tendons removal					?		X?						X		X		?	?
Scraping bones													X	X	X			
Bones breaking for marrow procurement					X		X						X	X	X	X	X	X
Recovery of grease contained in spongious tissue													X		X			
Use of bone as fuel																		X
Retouchers							X						X		X		X	
Other bone tools															X			
Use-wear analysis: sample studied	FC	FC	G	SP	G	B	G	FC	G (flint)	FC	B	B	G	G	No	G	TP	G
Number of active zones with use-wear traces	6	1	11	5	134	1	64	24	46	2	2	2	21	52		57	38	27
Number of analysed pieces	83	5	210	50	300	5	79	284	1200	7	5	5	2150	219		172	113	1983
Hunting points							X											
Butchery by cutting			XX	X	XX	X	X		XX		X		XX	XX		XX	X	XX
Butchery by cutting an scraping							XX											
Butchery by percussion	X							X						X				X
Defleshing fresh or moist hide					X				X									
Scraping moist hide							X											
Cutting dry hide							X											
Scraping dry hide									X				X			X		
Piercing hide														X		X		
Scraping bone or very hard wood				X	X		X		X					XX		X	X	X
Chopping wood	X				X			X		X		X						
Non percussive motions on wood					X		XX		X					X		X	X	

Table 71 - Summary of activities and modes of use identified by the zooarchaeological and use-wear analyses for each archaeological assemblage. Abbreviations: FC: flake cleavers; B: bifaces; G: complete; SP: selection of pieces; no: none; TP: triangular pieces.

In prehistory, the settlement models for the Middle Palaeolithic proposed by P. Depaepe (2009) are based on those defined by L.R. Binford and show a close relationship between the environment and modes of settlement. Group mobility was greater and there was a more marked specialization of sites during harsh climatic periods, in particular because the plant biomass was reduced and the animal species present lived in herds and were migratory (bison, reindeer, horse). Conversely, during temperate periods, the animal and plant biomass would have been more abundant within a smaller territory, all year round, leading to more reduced mobility within the occupied area and more diversified activities within a single site.

According to the models proposed by A. Delagnes and W. Rendu, there was a correlation between settlement systems and the technical traditions of groups, which can be an indicator of their behavioural patterns (Delagnes, Rendu, 2011): the Levallois and laminar technical groups would have been related to a residential system, while in contrast, the Quina and Discoid-denticulate technical groups would have belonged to a logistical settlement model with planned and specialized activities throughout the year. According to the authors, however, the mobility of the Discoid-denticulate groups was seen as opportunistic, while that of the Quina groups is more structured. Despite being very appealing, Delagnes and Rendu's model does not take into account all of the variability of the sites. This variability reveals a reality that is more complex and which shows that Neanderthals were not subjugated by their technical traditions (Thiébaut, 2013; Gravina, Discamps, 2015).

A - Site functions

Abri Olha I

Attempting to interpret the function of the site of Abri Olha I proves a complicated task due to the date of the excavation (Passemard, 1924) during which the collection of remains was selective. Moreover, the zone excavated incorporated a rather large surface area, while information regarding the site's stratigraphy is scarce and lacking in accuracy. Lastly, our use-wear study only involved one tool type from the industry, the flake cleavers.

Given the biased representation of remains, unmodified flakes are under-represented in comparison with retouched flakes. The number of flake cleavers (n=83) and bifaces (n=14) is considerable, even in such a context. Use-wear analysis of these objects shows that they suffered heavy alterations, in part due to post-depositional conditions, but also due to how they were stored, as numerous recent "drawer" scars are present on their edges. In spite of this, the working edges of the flake cleavers show signs of use for percussion on medium-hard and hard materials which cannot be confused with these recent accidents and which most likely indicate activities related to primary acquisition by percussion (tree-felling and carcass disarticulation) at the site.

Though also collected in a selective manner by E. Passemard, the faunal remains are numerous. The only palaeontological characterization which exists for this assemblage is from Passemard's analysis (1924) who interprets it as demonstrating a diverse fauna dominated by red deer, followed by horse and bison. Bearing in mind that this faunal assemblage is the result of a selection, the quantity of mandibles and teeth is nevertheless considerable.

Geomorphological analysis can also help to reflect on the possible functions of this site. The site has always been considered a rock shelter. However, following field observations (Sellami, pers. comm.), this bar of Kimmeridgian lithographic limestone takes the form of upright banks of rock, with deep faults which has only limited karstification properties (widening of faults, for example), and is incompatible with the formation of vaults or cavities. This observation is important in

terms of the establishment of settlements: Abri Olha has probably never been a true rock shelter with any real depth, but rather a settlement at the foot of a cliff, on the edge of a stream, close to its confluence with the Nive river.

Other data related to Abri Olha II will be presented in the following paragraph, and hypotheses about the function of these two sites will be put forward afterwards.

Abri Olha II

Excavation of the site of Abri Olha II took place over a small surface area of 6 m². However, the collection of material was much more systematic than at Abri Olha I and the location of some of the objects was measured in three dimensions (Laplace, Méroc, 1954), which provides a control for the distribution of remains within the stratigraphic sequence (Deschamps, 2009, 2014). At Abri Olha II, the analysis of the *chaînes opératoires* reveals the use of the Discoid and Levallois methods, but the high rate of exhausted tools does not always enable us to distinguish between the two systems (Peresani, 2003). While the raw materials were not entirely local, the most frequently used flint can be found nearby, approximately 10 km away; other raw materials are anecdotal. The blocks do not appear to have been brought to the site whole, and numerous cores demonstrate the exploitation of the lower faces of flakes. Biface production seems to have taken place on-site, at least partially (manufacturing flakes = 7 %). However, the flake cleavers were brought to the site in the form of finished tools, probably from the river which flows a few tens of metres from the site.

Flake tools are numerous (9.5 % of the overall remains) and attest to the substantial use of these tools, as shown by the many traces of resharpening. The number of flakes produced by the modification of working edges (retouch and resharpening flakes) is indeed considerable, which thus indicates an intensive use of the toolkit *in situ*.

Unfortunately, the poor preservation of the remains does not enable us to conduct in-depth use-wear analyses which might have helped to refine the results of the techno-economic analysis. Only one flake cleaver from the five analyzed showed percussion use-wear traces, and we were unable to determine the precise nature of the worked material (plant or animal).

This site nevertheless clearly resembles a *provisioning of places* type of settlement.

In conclusion, the large quantity of macro-tools (flake cleavers and bifaces), the intensive use of flake tools and the considerable quantity of faunal remains, in a topographical setting at the base of a cliff, may enable us to consider Abri Olha I and II as consumption sites, where the repeated activities included butchery, in part at least. Only a zooarchaeological study of the faunal remains from Abri Olha II could potentially confirm this hypothesis.

Bayonne le Prissé PM1

This first Mousterian level corresponds to an open-air site near (±2 km) to one of the most important regional raw material sources, the Ibarbide olistostrome in Mouguerre. Techno-economic studies have revealed that the initial phases of the *chaînes opératoires* were those most frequently found on site, while a tendency to take the products of full debitage, pseudo-Levallois points, from the site, was identified (Deschamps *et al*., 2016). The importing of whole or tested blocks to the site reveals a *provisioning of place* type of settlement, according to Kuhn's model (1995). However, this assemblage is quite weak, quantitatively, and retouched tools are rare (2.5 % of the total). The occupation was therefore only temporary, as is typically proposed in Kuhn's model. Several bifaces made from local flint and ophite and quartzite flake cleavers were also imported, resharpened (manufacturing flakes: n=19) and abandoned at the site, which would tend to suggest *individual provisioning*.

The lithic use-wear data indicate that despite a good level of preservation of the working edges, a very small number of the objects show signs of use (9 of 200 analyzed). The objects which do show use-wear traces are sub-products of the main *chaîne opératoire* (cortical flakes, atypical pseudo-Levallois points) or bifaces (n=3 of the 8 identified).

On-site debitage of blocks and the tendency to take the products in their originally intended state away from the site (as documented by both the use-wear analysis and refitting), while the tools are mostly made using cortical sub-products, in addition to the scarcity of use-wear traces, all indicate that the site's principal function was as a knapping workshop. All of the use-wear traces identified were associated with butchery, for cutting, thus attested in spite of the non-preservation of bone remains.

This association of activities fits into a spatial distribution of the remains that is clearly anthropogenic (Clark *et al.*, 2016), which manifests itself most clearly by the presence of piles of debitage with a differential distribution of certain sub-products and with macro-tools, retouched tools and used flakes (Deschamps *et al.*, 2016) mainly found on the edges of the debitage piles. It may be imagined that this butchery, ultimately limited, was secondary, i.e. that it corresponded with food preparation of meat provisions brought to the site in segments, for consumption during the use of the site. It may also have been a primary, opportunistic acquisition of animals happened upon by chance during the "expedition".

It is difficult to push this interpretation any further without taking into consideration two other sites located within a radius of 500 m. The site of Jupiter displays similar characteristics to Bayonne le Prissé, in terms of both the techno-economic and the use-wear aspects, which supports the idea of a possibly real link between the butchery tools and the activity of a production workshop (Colonge *et al.*, 2017b). Furthermore, a third site, Le Basté, also contains the same technological associations (Discoid debitage and bifaces), but in opposite proportions: it appears to have been mainly a workshop for the manufacturing of bifaces, while elements relating to debitage are less frequent, though they are characterized by the same production method (Discoid).

The most logical hypothesis for Bayonne le Prissé PM1 is therefore that it was a site with combined functions, involving a knapping workshop as its principal activity, associated with a secondary butchery activity. The absence of faunal remains unfortunately does not allow us to gain more information about this activity. The duration of the occupation appears to have been very short, and it was relatively specialized, probably a satellite site for a more permanent settlement.

Bayonne le Prissé PM2

The second level attributed to the Middle Palaeolithic at Bayonne le Prissé is very different from the first, from a techno-economic point of view. Even though the importing of blocks and the presence of (almost) complete *chaînes opératoires* have also been identified in this level, there was no evidence for the removal of the originally intended products from the site. The raw materials here were exploited to a maximum: the large majority of the cores were used until a very small thickness remained and virtually all of the secondary volumes of blocks (protuberances on nodules, large first flakes, debris) were exploited using less structured methods (unipolar, centripetal, Kombewa). The form of debitage almost exclusively used was Levallois, mostly of preferential flakes, followed by recurrent centripetal debitage. The number of retouched products is much higher (7 %) than for PM1 and consists mainly of side scrapers. Backed bifaces also occur in the assemblage (Colonge *et al.*, 2015; 2017a). The biface manufacturing flakes, present in low numbers, do not appear to indicate the production of bifaces at the site. This provisioning strategy of this settlement thus appears to resemble that of *place provisioning*.

The use-wear analysis only examined a selection of tools for which, despite more substantial alterations than for Bayonne le Prissé PM1, showed a higher percentage of use-wear traces (10 % for PM2 compared with 4.5 % for PM1). The wear identified was predominantly related to cutting soft to medium-hard material and most likely corresponds with a butchery activity. One object also enabled us to record scraping activity on a medium-hard to hard material, which may have been plant (hardwood) or animal (bone).

The site may have functioned as a residential settlement, the duration of which is impossible to determine, and where production was intended for on-site use, unmodified or retouched, in the context of activities which may have been more diversified (mostly the cutting of soft to medium-hard material and scraping of medium-hard to hard material). In the absence of bone remains, it is difficult to obtain further clarification regarding the activities which characterize this settlement. Further use-wear studies might nevertheless enable us to refine these results.

Chez-Pinaud

A preliminary technological study was conducted on the lithic industry from contexts US 06/07 at Chez-Pinaud, attributed to the Mousterian of Acheulean Tradition (Jaubert *et al.*, 2008) but, unlike levels 08 and 22, no advanced archaeopetrographic study took place. Nevertheless, on-site exploitation of local flint blocks is attested by a large number of cortical pieces (*provisioning place*). A few objects made from non-local raw materials (side scrapers, denticulates, bifaces and biface debitage flakes) illustrate parallel *provisioning of individuals*. The assemblage is characterized by flake debitage using the Levallois and Discoid methods and by biface manufacturing (Jaubert *et al.*, 2008). Of a total of 48 bifaces[6], some, made of non-local material, were probably imported fully shaped, since no corresponding knapping waste products were found on the site. Biface manufacturing nevertheless took place *in situ*, since the flakes from biface production in local flint are relatively numerous (more than 300 in the collection from the recent excavations, Claud, 2008) and relate to various production phases: roughing out of bifacial pieces, shaping *sensu stricto* and edge retouch. The bifaces were found in different stages of reduction: bifaces at the start of their use-life, bifaces which had undergone multiple resharpenings but which still had convergent, sharp edges, and bifaces deformed by abrupt and irregular retouches or by notches (Claud, 2012). The flake toolkit is predominated by side scrapers and notched tools (Jaubert *et al.*, 2008); some of the side scrapers were made using biface manufacturing flakes, and some of these were made from non-local raw materials (Turonian).

The stone tool industry is associated with a faunal assemblage which has been the subject of several studies (Bourdillat, 2004; Mallye *et al. in* Jaubert *et al.*, 2008), and demonstrates a diverse spectrum dominated by large bovids and horse, but whose analysis is limited by alterations caused by the weathering and transporting of the remains. Nevertheless, a small number of cutmarks from butchery were observed, as well as notches from percussion. The high numbers of burnt bones may indicate the use of this material as fuel.

Data from the use-wear analysis carried out on the lithic industry enables us to confirm that butchery activities took place at the site, as the use-wear traces from this activity are very numerous. A large proportion of the tools identified (flakes produced through debitage and biface manufacturing, side scrapers, denticulates, bifaces) was used for cutting, and more rarely for percussion.

6. Found during the excavations of J. Airvaux and M. Soressi (Airvaux, 2004) and those of J. Jaubert, J.-J. Hublin, S. McPherron and M. Soressi (Jaubert *et al.*, 2008).

There is also evidence for hide working at the site, based on the presence of unmodified flakes and side scrapers (eight objects in total) which show traces of longitudinal actions on hides that were fresh or drying (neither dry nor fresh, but still supple). Given the marked convexity of most of the working edges used for this type of function, the hypothesis of their use for hide defleshing via a tangential motion seems to us the most likely. This activity could have taken place just after the cutting up of the animals shortly after their slaughter, as this work is easier when the hide is still in a fresh state. Conversely, no evidence for the working of dry hides was identified. This absence cannot be explained by a problem of preservation or of interpretation. Of course, we cannot exclude the possibility that other stages of the processing of hides, in particular once dried, took place at the site, or in the immediate surrounding area, or the use, for such operations, of other tool types (see Part II, chapter 4.3).

It may be supposed that other activities took place at the site, due to the presence of a small number of tools (flakes and denticulates of varied morphologies and dimensions) which show macro-traces associated with working a medium-hard material such as wood, primarily by scraping, but also more rarely by percussion and sawing. The absence of micro-polish in association with these macro-traces (which introduces doubt as to the material being worked and possibly suggests a short duration for the work) and the rarity of these elements compared with those used for butchery and to a lesser extent hide working, point towards the practice of a secondary or even marginal activity. Lastly, the few objects (three flakes, one biface) with macro-traces caused by the scraping of a hard organic material may correspond with the removal of meat attached to bone, to the preparation of the bone prior to breaking (as evidenced at the site by the presence of percussion notches), or to the working of a particularly hard woody material.

While interpretations of the function of this site are limited by the state of preservation of the bones, the initial techno-economic data, the nature of the faunal spectrum, and the results of the use-wear analysis enable us to suggest that the site functioned as a residential camp.

Combe Brune 2

The open-air site of Combe Brune 2, located in the town of Creysse, covers 1 550 m² on the northern part of the Pécharmant plateau, a few dozen meters south of the site of Combe Brune 3. The chrono-stratigraphic sequence, which is truncated to the east of the site, revealed a small and understated ensemble dated to the late Middle Palaeolithic (Brenet *et al.*, 2016). This comprises five isolated objects, found in an area measuring approximately 50 m². They are all made of local Bergeracois flint. It is nevertheless difficult to determine if this was sourced from blocks which came from the decomposed rocks observed on the outskirts of the site, or from other formations present elsewhere on the Bergeracois plateau.

The five objects are bifacially shaped tools in various stages of production: two virtually completed bifacial pieces – heart-shaped and made from cortical flakes –, one basilar part of a broken biface made from a flake, a roughout of a bifacial object on a cortical flake and a bifacially retouched backed knife made from an elongated flake.

The economic interpretation of this small assemblage of bifacial tools, without any associated manufacturing flakes, tends towards that of a short stopping place where consumption took place, and tools manufactured elsewhere and brought to the site (*provisioning individuals*) were abandoned. Use-wear analysis identified wear associated with cutting a soft material (possible butchery, low intensity wear) on one heart-shaped biface (perhaps two), and possible traces of percussion on a medium-hard material on another object. Thus, two types of activity may be represented at the site: butchery by cutting, and, perhaps, the acquisition of woody materials by percussion.

Coudoulous 1

At the top of a sedimentary sequence of approximately eight meters in depth (Jaubert *et al.*, 2005), layer 4, which was deposited about 160 ky ago during OIS 6 (Hernandez *et al.*, 2015) is the most anthropogenic context. It contained an abundance of stone tools and a rich faunal assemblage. The industry is predominated by raw materials considered mediocre, namely quartz and quartzite, which were accessible in the form of pebbles a few hundred meters from the site in the Lot and Célé rivers. These were knapped using Discoid debitage *sensu lato* and debitage on an anvil, with the principal objective being to obtain flakes with two converging edges opposite a thick neocortical butt (Mourre, 1994; Jaubert, Mourre, 1996). Flint, of local origin for the most part, only represented approximately 4 % of the assemblage. This material was mainly knapped using recurrent centripetal Levallois debitage, as evidenced by cores and unmodified flakes. The retouched flint tools are typical of the Mousterian (single, double, and convergent side scrapers, Mousterian points).

The functional interpretation of the site at the time that layer 4 was deposited was proposed when excavations were resumed by J. Jaubert and J.-Ph. Brugal (see in particular Brugal, David, 1993; Brugal, 1995, 1999; Brugal *et al.*, 1996; Jaubert *et al.*, 2005). It is essentially based on the characteristics of the faunal assemblage, which almost exclusively comprised bone and tooth remains from bison with an MNI of 232 in the approximately twenty square meters that were excavated. This figure can probably be doubled if we take into account the part of the site which was destroyed. The catastrophic profile of the mortality curve (with a majority of juveniles followed by decreasing proportions of adults and aged individuals), the presence of loosely connected anatomical elements, the frequency of resh fractures on long bones, sometimes accompanied by impact points and cutmarks (even if rarely observable for taphonomic reasons) all point towards an anthropogenic origin for this assemblage. The favoured hypothesis is that of the use of the site's geographical (confluence of the Lot and the Célé) and topographical (edge of a plateau, proximity to cliffs) characteristics by Neanderthal groups in order to carry out the seasonal (end of spring – beginning of summer, according to the stages of tooth eruption) driving of herds or parts of herds of bison towards the natural trap formed by the opening of the sinkhole. The animals would then have been killed, before being butchered and probably partly consumed at the site (some evidence for combustion was found in the archaeological layer) or in the immediate vicinity.

Use-wear analysis of the quartz and quartzite industry of layer 4 from Coudoulous 1 (Venditti, 2011, 2014, Part II, chapter 2), based partly on experimentation carried out in the context of the PCR, has enhanced this functional interpretation. On the one hand, it appears to confirm the practice of hunting activities, through the unexpected discovery on two quartz objects of traces which may indicate their use as weapons. On the other hand, the identification of micro-traces interpreted as being related to woodworking (scraping and sawing) on eleven working edges offers an interesting perspective. Although this activity is not directly linked to the actual acquisition of game, it may take place just beforehand (e.g. for the production of hunting spears) or just afterwards (e.g. for making frames or handles for processing hides, as part of their conservation). The identification of a zone showing traces of prehension (contact with leather) confirms this diversity in the activities carried out. These results enable us to see the site as having existed for a certain length of time, at least for longer than necessary for simply killing the bison and obtaining the corresponding food resources. It is clearly unfortunate that the poor preservation of the flint objects prevented us from gaining valuable information regarding the diversity of activities which took place, or even a potential complementarity between the various raw materials used.

El Castillo

During the excavations directed by H. Obermaier, H. Breuil and P. Wernert from 1910 to 1914, layer alpha revealed almost 300 flake cleavers (Obermaier, Pérez de Barradas, 1924 ; Cabrera Valdès, 1984). It is important to note that the assemblage is the result of the selection of the most remarkable artifacts during the excavation of the site. In recent excavations (Cabrera Valdès, Bernaldo de Quirós [eds.]), layer alpha, renamed layer 20, was subdivided into five different levels (Sanchez Fernández, Bernaldo de Quirós, 2008). As we were only able to access the material from the earlier excavations, we have focused our study on the flake cleavers.

Though their level of preservation at times hindered the reading of the use-wear traces, 24 of the 284 objects analyzed were identified as having been used for percussion on materials compatible with wood or bone (Deschamps, 2014; Claud *et al.*, 2015). To date, this collection is the largest assemblage of flake cleavers discovered in a context dated to the Middle Palaeolithic in Western Europe. The large quantity of remains is most likely evidence for this site's specific function, which we are unfortunately unable to determine at present.

Fonseigner

Fonseigner is an open-air site with a small adjacent rock shelter, situated at the foot of a cliff oriented south-south-east. The lithic industry from upper level D (Dsup), dated to a Mousterian of Acheulean Tradition, was the subject of a technological study (Geneste, 1985; Boëda *et al.*, 1990).

The faunal assemblage associated with the lithic industry is comprised of the remains of *Bos*, *Elephas primigenius*, *Capreolus capreolus*, *Equus caballus* and *Rangifer tarandus* (Delpech *in* Geneste, 1985) but regrettably, no zooarchaeological study was carried out.

Most of the flint used was local, with deposits located approximately 3 km away. All phases of the *chaîne opératoire* are represented on the site (Boëda *et al.*, 1990), attesting a *provisioning place*. A few objects in non-local flint were found, most of which were retouched and are characterized by the "technological quality of the debitage and of the retouch" (Geneste, 1985), which also shows *provisioning individuals*. Some of the flint came from more than 50 km away.

The debitage is characterized by the use of a Levallois method, bipolar for the most part, but sometimes unipolar or with a semi-peripheral striking platform. The flakes were at times retouched to form side scrapers, Mousterian points, backed knives, notches or denticulates (Geneste, 1985). However, a large proportion of the notched pieces are in fact pseudo-tools, their retouches being of natural origin (Claud, 2008: 251-252). Biface manufacturing is attested by the presence of six bifaces and approximately forty biface manufacturing flakes, one of which was retouched to form a side scraper. Made of local flint, all the bifaces were probably not shaped on-site, given the small quantity of manufacturing flakes recovered. At least some of them were therefore imported. Biface mobility is also demonstrated by the presence of six manufacturing flakes in various non-local flints, one of which was retouched to produce a side scraper (Geneste, 1985; Claud, 2008: 265).

Alongside the flint industry, an industry using pebbles of various raw materials (quartz, quartzite, schist, mica schist, granite, gabbro) was also found. Hammerstones, pebble tools, unmodified and retouched flakes were recovered, but, to date, these have not undergone use-wear analysis. Nevertheless, J.-M. Geneste has highlighted the presence, on several choppers and chopping tools, of wear probably caused by use for percussion on resistant materials (Geneste, 1985: 60, fig. 137).

The results of use-wear analyses carried out on the flint industry demonstrate a relative diversity of activities practised at the site: butchery via cutting is indeed dominant, but hide working, in a fresh or moist and dry state, through cutting and scraping, is also well-represented, along with a few tools which were used to scrape medium-hard or hard materials of an indeterminate nature.

Longitudinal actions on hide may correspond, for the majority of tools in question (side scrapers) with a hide defleshing stage, based on the nature of the use-wear traces observed (associated with fresh or moist hides) and edge morphology (see Part II, chapter 4.3). The hides of animals killed at the site were therefore probably fleshed on-site, in conjunction with the butchery of the carcasses. In the absence of a zooarchaeological study, it is not possible to go into more detail about the *chaîne opératoire* of butchery carried out at the site. Such studies would allow us to determine if the carcasses were whole or if, conversely, parts thereof were exported or imported, but also to confirm, or not, the presence of cutmarks typical of hide removal. As regards the working of dry hides, by scraping (one tool was used for cutting and for scraping), identified on six objects (side scrapers and flakes), its presence may illustrate the sequence of a hide processing *chaîne opératoire* on-site. This work may have corresponded with a dry defleshing (with defleshing of previously washed hides being finished while still fresh or moist via tangential cutting, or defleshing of still unwashed hides) or even with an earlier step in the processing of the hide (reduction, hair removal, ...).

Given that the pebble tool industry also potentially shows signs of use related to percussion (see above), the spectrum of activities carried out at the site may be much wider than that shown by the results of our analyses conducted on the flint.

Ultimately, the functional data obtained for the flint industry confirm the hypotheses put forward by J.-M. Geneste (1985) on the function of the site based on the techno-economic study, that is, a mixed facies of production and consumption and relatively long occupations, which may have been a residential settlement.

Gatzarria

A techno-economic and petroarchaeological study was carried out on the Cjr level from Gatzarria (Deschamps, 2014). Only the flake cleavers, of which there were seven, underwent use-wear analysis. The faunal data simply consist of a palaeontological study of this level (Lavaud, 1980), while a more recent and more detailed study was carried out on the layer above (Ready, 2013; Ready, Morin, 2013).

The industry of level Cjr at Gatzarria was produced using 90 % quartzite. On these local materials, the *chaînes opératoires* were carried out on-site, for the most part. Conversely, the flint artefacts appear to be the result of selective importation. Although they represent a small percentage of the overall remains, the origins of the flint materials are very diverse, as they come from almost all of the known regional resources, and even some extra-regional ones (Deschamps *et al.*, 2017). The convergence of mineral resources at this site clearly suggests a relatively permanent residential type of settlement, associated with logistical expeditions from which came the various resources. It resembles a *provisioning of place* type of settlement.

Flake tools represent 7.5 % of the remains and are predominantly made of quartzite, followed by flint. Amongst the flint objects, there is an over-representation of retouched tools. It is also the flint tools which show the most frequent signs of resharpening, demonstrating a more intensive use of these tools in comparison with those made from local materials. Two ophite flake cleavers show traces of percussion from being struck against medium-hard to hard materials. No bifaces were identified.

A field project which is currently ongoing at this site (Deschamps, Flas [dir.]) will enable new data to be acquired, relating to levels dated to the Middle Palaeolithic, in an updated stratigraphic framework.

Grotte du Noisetier

Grotte du Noisetier is a small Pyrenean cavity of which an area of about thirty meters squared has been explored. It has revealed a relatively complex sedimentary sequence dated to a temperate episode of marine isotope stage 3. The apparent uniformity of the faunal assemblages and the lithic industries throughout the sequence is probably misleading and probably masks diachronic changes in the site's function. At this stage of research on the site, these modifications are all the more difficult to decipher because, in the approximately thirty archaeological levels identified to date, the majority have only been uncovered within a limited surface area. Furthermore, their levels of preservation are very inconsistent: some have clearly suffered bioturbation (US I to IV), others have been visibly affected by subsidence or even cryoturbation (layers 32, 33?), while another contained a combustion feature which was particularly well preserved (layer 1). The field and laboratory work are still ongoing and it is too early to suggest an overall definitive functional interpretation of the various occupation layers. A certain number of points can nevertheless be raised based on the work carried out thus far, in particular thanks to the PCR's contribution.

The hypothesis put forward by our predecessors of a single function for the site, related to the exploitation of mountain fauna (Pyrenean chamois and ibex) by small groups of Neanderthal hunters can already be considered obsolete. Without going into too much detail about how this was demonstrated, which occurred in several stages (Costamagno *et al.*, 2008; Mallye *et al.*, 2012a), taphonomic analysis established that the chamois bones, and a substantial part of the ibex bones were accumulated by a non-human predator, most likely the dhole. However, bone remains of red deer, large bovids and, to a lesser extent, ibex, were the result of hunting activities carried out by Neanderthal groups and bear traces of the subsequent butchery activities. In the most anthropogenic layers (layers 2, 33, 3 and gb), cutmarks on the long bones of red deer indicate that skinning and defleshing were carried out at the site. In layers 3 and 33, longitudinal cutmarks are present on the lateral surface of the hooves, indicating that the removal of the skin here was distinct from that of the rest of the carcass: this operation may have taken place in two stages, or even in two different places (Costamagno, David, 2009), with limbs covered in skin being detached from the carcass at the kill site, and then transported to the settlement. The carcasses were extensively processed for food: meat and bone marrow were removed, but the fat contained in the extremities of the joints was also exploited (Costamagno, 2013). Furthermore, the removal of tendons has been identified in these four layers, suggesting a technical use for parts of the carcasses. This latter type has also been demonstrated by the use of fragments of diaphysis as retouchers (Mallye *et al.*, 2012b).

The modes of lithic raw material acquisition are generally the same all through the sequence. Mineral resources available locally in the form of pebbles in the Neste river are the most common, in particular quartzites and schists. Certain varieties (fine-grained quartzites) or certain rocks (lydite) seem to have been specifically sought, as they are present in greater proportions in the archaeological assemblages than in the currently accessible fluvial formations. The flints, whose closest deposits are located approximately thirty kilometers away as the crow flies (Hibarette), make up around 6 % of the lithic assemblages of the various levels. The only significant exception is layer gb, where approximately 20 % of the lithics were made of flint. Materials from further afield are rare but provide valuable information regarding the areas that were known, or even traveled (Deschamps *et al.*, in press). In layers 1, gb and 33, a few remains indicate the movement of materials from Chalosse and Béarn, over 100 km to the north-west. In layer 2, three Danian flint objects probably came from the Petites-Pyrénées, more than 30 km to the north-east.

From a technological and typological perspective, the lithic assemblages are also relatively homogenous throughout the sequence. Discoid debitage, uni- or bifacial, is omnipresent and predominant. Levallois debitage on quartzite is attested by three cores (US 0, layers 2, 33) and by characteristic

products in virtually all levels. Biface manufacturing is attested by the presence of bifacial pieces (layers 1, 32) and characteristic flakes in variable proportions all through the sequence. Two flake cleavers (US III, layer 1) are also present. Layer gb once again sets itself apart by its large numbers of retouch flakes, particularly in flint, and by a higher frequency of retouched tools (30.1 %). Side scrapers and denticulates are the most common tools. The only side scraper with Quina retouch was found in layer gb. Although edge preservation is imperfect and clear wear traces rare, the use-wear study of the lithic industry from Grotte du Noisetier has highlighted several functions. Cutting of a soft to medium-hard material, probably linked to butchery, is very much predominant (US III, layers 1, 2) even though its importance has most likely been underestimated. Scraping of dry hide has also been identified on one tool from layer 2. A few objects may also have been used for percussion / sawing or even scraping on medium-hard to hard materials, which could also possibly be related to butchery (disarticulation by force, cleaning of bones, ...). Processing of plant materials appears underrepresented. Three tools show traces of use as hammerstones, and one flake had traces on its faces which are probably due to abrasion or polishing of an indeterminate material. The scarcity of use-wear on flint objects cannot be systematically explained by taphonomic issues, since several of these look fresh. This absence may be due to the fact that the flint tools were typically resharpened a final time at the site, before being used too briefly for traces to develop. The small percentage of traces observed may be related to a conjunction of taphonomic, economic and functional factors (low rate of use of unmodified flakes produced and abandoned in the cave?).

Anthropological data can also be mobilized to attempt to interpret the function of the site. To date, four human remains have been found at Grotte du Noisetier (Maureille *in* Mourre *et al*., 2013). These remains are comprised of four tooth fragments from an adolescent or young adult (layer 1a), a child of 6 years ± 24 months (layer 1), a child of 7 years ± 24 months (layer 1a) and a child of 6-7 years or perhaps a little older (layer gb). If we consider the layers in which these remains were discovered and the compatibility of the rates of dental wear for the deciduous teeth, these correspond with a minimum of three individuals, comprising one adolescent / young adult and two children. The final three remains could nevertheless belong to a single child if we consider that the last fragment may have moved from layer 1 to layer gb below, caused by post-depositional phenomena. In any event, the cave was visited repeatedly by Neanderthal groups including one or several children since these deciduous teeth do not fall out at the same time.

The site of Grotte du Noisetier most likely had diverse functions for the various Neanderthal groups which occupied it. Nevertheless, it seems clear that its function was never limited to that of a hunting camp related to the exploitation of mountain species. It appears more likely that it functioned as a residential site for groups which were not restricted to a few hunters, but which rather included one or more whole families. The activities which were carried out there indeed gave importance to the acquisition of meat-based food resources (skinning, defleshing, removal of meat and bone marrow, extraction of fat from the extremities of joints). However, this was not exclusive, as evidence for technical activities was also uncovered: scraping dry hides, extraction of tendons but also clearly flake debitage, manufacturing or resharpening of bifacial tools, resharpening of flint flake tools, and abrasion or polishing of an indeterminate material on the faces of a large schist flake. Information regarding a possible seasonality of occupation is regrettably extremely limited, in the absence of a meaningful number of tooth remains in the various levels. Curiously, dhole remains are present throughout the whole sequence, and it is therefore likely that the Neanderthal groups shared the site with these carnivores. Ethology of modern-day dholes suggests that the cave probably repeatedly served as a den during at least half of the year (Mallye *et al. in* Mourre *et al*., 2013). Grotte du Noisetier may therefore have been used as a residential site by full groups of humans and for relatively short periods of time. The small number of red deer and large bovid remains identified, even in the levels with a higher quantity of anthropogenic material, fits well with this hypothesis.

La Conne de Bergerac

La Conne de Bergerac is an open-air site located on the left bank of the Dordogne river, where excavations took place over 1 710 m² (Brenet *et al.*, 2016). A single, shallow archaeological layer was identified at the upper level of the middle terrace – or a disturbed part thereof – of the Dordogne.

The raw materials exploited are all of local origin, and two-thirds are of alluvial origin: Senonian, Tertiary lacustrine or Maastrichtian flint and metamorphic rocks; these can all have been acquired from the neighboring terrace or the banks of the Dordogne, or else in the surrounding landscape, no more than 5 km away. In quantitative terms, the majority of the stone tools are made of flint; these consist of various products and waste products of Levallois and Discoid debitage, a few biface manufacturing flakes and six bifacial tools. The less common use of quartzite is demonstrated by approximately ten flakes, cores and pebble tools.

Debitage products, Discoid (n=168) and Levallois (flakes, often laminar, n=164), display varied methods and means. All categories of debitage products and waste products have been identified, though with a consistent underrepresentation of artefacts measuring less than 3 cm. It appears that Discoid debitage was carried out preferentially on Tertiary lacustrine flint and Levallois debitage on alluvial Senonian flint.

Debitage on the lower face of flakes, represented by ten cores, eleven flakes of full debitage, of varying types, and a pseudo-Levallois point, could be simply a temporary means – a sort of subdivision – within the Levallois and Discoid debitage methods. The rate of transformation of flakes produced is low (4.3 % of the blanks from debitage) and within the toolkit, side scrapers are predominant. Biface manufacturing is represented by eleven manufacturing flakes and six bifacial tools, made of flint. The assemblage is remarkable for the complexity of the bifacial tools – at various stages of manufacture and with varied volumes – thought to be blanks for multiple tools. Only two pieces are technologically intact, the others are notably damaged by frost and broken. Four are made of Maastrichtian flint, the two others of Senonian flint. Five of the eleven biface manufacturing flakes identified are Senonian flint, three are Maastrichtian flint and two are Tertiary lacustrine flint.

The debitage is characterized by a high rate of cores and a rather marked shortage of their initial phases of debitage. It therefore seems that, for the most part, the advanced phases of debitage were carried out *in situ*. The pieces destined to be knapped may have been brought to the site already roughed out or partly used.

The very limited presence of biface manufacturing flakes demonstrates that the bifacial tools were not shaped and modified little or not at all on-site; they may have been brought to the site at an advanced stage of their technological history, to be used there. Indeed, two of these show use-wear traces from cutting soft material, probably in a butchery context, as attested by the presence of meat and/or skin polish on one of them. A third biface could, without certainty, have been used for percussion on a medium-hard material such as wood.

This thus suggests that the site was a temporary place between deposits of raw materials and one, or several, more permanent settlements. Partial activities of flake production and consumption took place here. In order to clarify the activities carried out, a comprehensive use-wear study would need to take place. A large proportion of the blanks, retouched or not, were taken away from the site towards potential consumption sites. The imported bifacial toolkit also shows the probable link between the site and other settlements specialized in the manufacturing of these tools such as has been observed at the nearby site of La Graulet (see below).

La Graulet

The open-air site of La Graulet is located on the left bank of the Dordogne. Excavation of a total surface area of 890 m² revealed a small lithic assemblage (Brenet *et al.*, 2016).

The state of preservation within the collection is variable, with almost 80 % of the objects being intact. Only four objects measuring less than 3 cm, only one of which was whole, were found, which appears to suggest that the layer may have been affected by flowing water before being buried. Virtually all of the objects are made from alluvial flint, which may have been collected *in situ* or in the immediate vicinity on the terrace upon which the archaeological remains were located. Maastrichtian and Tertiary lacustrine flint, which were also used, are accessible less than 5 km north or south of the Dordogne.

Two *chaînes opératoires* of flint debitage – Levallois and Discoid – are present. Neither is represented by sufficient numbers of artefacts to be considered dominant. Given the mechanical alteration of the working edges of certain objects, only two retouched flakes could be identified with certainty; these comprised a straight transverse side scraper and a retouched pseudo-Levallois point.

The five bifacial tools are made of Maastrichtian flint, of local alluvial origin in two cases. Their state of preservation is quite good; overall, it is better than that observed on the flakes from debitage *chaînes opératoires*. The absence of biface manufacturing flakes indicated that these bifacial tools were imported to the site at an advanced stage in their use-life, as was observed at La Conne de Bergerac. They were probably brought to the site, where they were used and abandoned, while short incomplete sequences of debitage would also have been carried out there. Use-wear analysis has revealed macro-wear on two of the pieces which is compatible with use for percussion on a medium-hard material such as wood.

The stone tools from La Graulet, at least with regards to the bifacial tools, show characteristics in common with the industry of the nearby site of La Conne de Bergerac and may indicate one or several short visits by human groups and very specific consumption activities, also of short duration.

Les Fieux

Layer Kdenticulates from the site of Les Fieux has benefited from a recent interdisciplinary approach, and the technological and zooarchaeological results, in addition to the use-wear results obtained as part of the PCR (Gerbe *et al.*, 2014), make it possible to propose several potential settlement patterns.

This level is characterized by the production and on-site use of lithic blanks (presence of various elements of the *chaîne opératoire* on flint as well as quartz and quartzite). We are therefore dealing with a *provisioning of place* strategy.

Acquisition of animal carcasses on-site due to several individuals falling into the sinkhole has been proposed (Gerbe *et al.*, 2014), but the scarcity of axial skeletons calls this into question. According to M. Gerbe (2010), this underrepresentation could be the result of poor preservation of the spongy parts of bones but, on the basis of the available data, the hypothesis of *in situ* slaughtering of animals seems tenuous. Moreover, the poor state of preservation of the bone surfaces prevented a detailed study of the cutmarks from butchery. Nevertheless, various activities could be identified (Gerbe, 2010), such as gutting, removal of the tongue, skinning, and defleshing of fresh carcasses (bison and red deer). The presence of traces of scraping on the tibia of a European ass has been interpreted as evidence for later removal of meat, associated with potential scavenging (Gerbe, 2010). Lastly, traces of percussion identified on long bone fragments attest to the collection of bone marrow. These different activities indicate that carcasses were processed at the site. The absence of evidence that nutrient-rich elements were removed from the site suggests consumption

took place *in situ*, even if we cannot rule out the taking away of meat. The minimum number of individuals for bison is high (n=31) and, as the processing of carcasses was intensive, this suggests that a large volume of food resources was retrieved. The settlement focused on hunting bison during the winter months, while during summer months, red deer were favoured.

The activities carried out, brought to light by stone tool use-wear analysis, do not appear to be very diverse. The absence of charcoal prevents us from considering the collection of wood, even dead. Some evidence for potential wood working, principally by scraping, may be linked to the manufacture or maintenance of hunting spears, or structures for hide working. The latter activity is very rarely recorded by use-wear analysis, since only one tool may have been used to pierce hide. As mentioned above (see Part II, chapter 4.3), tools other than knapped stone could have been used and the processing of hides may also have been carried out elsewhere. Evidence for the scraping of a hard material like bone, very hard wood or heated wood could be linked to two distinct activities but which can be related to the acquisition or exploitation of carcasses. With regards to bone scraping, given the absence of a bone retoucher in this layer, and the known presence of long bone breakage, this contact could be evidence for the scraping of certain parts of the bones prior to breaking them. It could also be linked to traces of scraping recorded on the European ass tibia and interpreted as the retrieval of meat from a dried carcass. With regards to the scraping of hard wood or wood hardened by fire, the repair of already dry spears or the resharpening of their points could be suggested, in direct relation to the acquisition of game.

In light of the limited diversity of activities present at the site, layer Kdenticulates functioned as a seasonal site occupied by a single or several groups during:

- winter settlements of the sinkhole related to the acquisition, processing and consumption of bison. The Neanderthals of Les Fieux appear to have reoccupied the site seasonally in order to hunt the herds of bison present in the site's surrounding area during the winter so as to obtain abundant meat resources, some of which were consumed at the site. The limited diversity of activities in addition to the absence of charcoal or burnt bone suggests relatively short-term settlements which may imply storage of some of the animal resources for later consumption. Not simply a butchery site *sensu stricto*, this was therefore a residential type of seasonal settlement by a group of individuals during part of the year, which allowed them to shelter but also to acquire and process the carcasses of large ungulates with a view to possible storage of the meat;
- one or several other occupations, between the end of summer and the end of autumn, as a seasonal dwelling place.

Les Pradelles

Facies 4a at Les Pradelles, along with those underneath it, belong to a Quina type of Mousterian (Meignen, 1988; Meignen *et al.*, 2007; Costamagno *et al.*, 2017). Earlier studies carried out on layers 9 and 10 of Vandermeersch's excavations and level 2 of Maureille and Mann's excavations showed that the site had functioned as a hunting camp devoted to the butchery of reindeer carcasses (Costamagno *et al.*, 2006; Rendu *et al.*, 2011, 2012). The site, located close to several watercourses which may have formed favoured migration corridors for reindeer populations, must have been a place of strategic importance for the Neanderthals when conducting large collective seasonal hunts. The introduction of ready-to-use tools with guaranteed maintenance ("curation behaviour"; Binford, 1979) also makes it possible to put forward the hypothesis of short-term settlements during which the time spent on tool preparation was limited (Meignen *et al.*, 2007).

Facies 4a shows numerous similarities with those found underneath, which have previously been described (Costamagno *et al.*, 2017). Thus, the overabundance of reindeer attests to targeted hunting of this prey, probably during the species' migration periods, in particular in the autumn.

The reindeer killed near the site underwent primary butchery at the kill site, with the most nutritionally rich parts being transported to the settlement site. The lithic data show that this facies fits with a short-term, *provisioning individuals* type of settlement. The Neanderthals arrived at the site with an array of tools which were ready to be used, and "*matrices*", which were "general-purpose" or had "tool-making potential" (Bourguignon *et al.*, 2006). During these short stays, tools manufactured *in situ* from local raw materials completed the toolkit used to carry out the planned activities. The overabundance of retouchers relative to the retouched tools suggests that tools were carried off to be used for activities taking place away from the site (primary butchery of reindeer carcasses at the kill site, processing of hides on the plateau or transporting tools to another site) (Costamagno *et al.*, 2017). The reindeer parts brought into the interior of the cavity underwent intensive secondary butchery which enabled a large quantity of food resources to be obtained, some of which may have been consumed on-site, but some of which was also exported. The short durations of the occupations of the site prevent us from imagining that the totality of the resources would have been consumed at the site (Costamagno *et al.*, 2017). As use-wear analysis of the lithics could not be carried out within the PCR, only the analysis of the butchery marks enables us to add some further information regarding the site's function. The abundance of longitudinal cutmarks may be evidence for the removal of meat in strips, supporting the previously formulated hypotheses of short-term settlements for the butchery of carcasses and the creation of food reserves for consumption at a later time.

Mauran

Earlier works interpreted levels XV2 (C2) at Mauran as a settlement specialized in the mass slaughter of bison herds and the primary butchery of their carcasses (Farizy *et al.*, 1994). This level does indeed show the types of characteristics to be expected from such a function: the bison were killed on-site (the axial skeleton was present) at the end of the summer months (Rendu, 2007). However, the stone tool industry provides evidence that blocks of local raw materials were brought to site, where they were knapped, which does not appear to fit with a *provisioning individuals* model. The processing of the carcasses of the numerous animals that were killed (MNI=137, according to David *in* Farizy *et al.*, 1994) may explain the presence *in situ* of all of the elements of the *chaîne opératoire*. The authors have brought to light an underrepresentation of the long bones, indicating that the fattier parts of the animals were taken from the site. The presence of bones still in anatomical connexion and unbroken long bones underlines the absence of an exhaustive exploitation of the carcasses resulting from the abundance of animal resources available during a slaughtering episode (Rendu *et al.*, 2011). The nature of this site shows similarities with Palaeo-Indian kill sites (Farizy *et al.*, 1994). The processing of carcasses therefore probably took several days. The cutmarks observed attest to skinning of the carcasses, defleshing, disarticulation activities with cutting tools and breaking bones to obtain the marrow. Certain fleshy and fat-rich parts of the carcasses were taken away from the site, which may indicate the practice of storing animal resources by a single group, or the sharing of these resources between different groups.

The predominant activity was therefore slaughtering and primary processing of bison carcasses, which went hand in hand with the production of a significant quantity of stone tools on-site and the occupation of the site over several days. The activities identified by the use-wear study support this functional interpretation. Indeed, butchery by cutting is the predominant activity. With the exception of possible evidence for hide piercing (piercing of a soft material) on one piece, and another tool which was probably used to scrape dry hide, tools used for hide working are lacking. The poor level of preservation of the working edges may be why hide defleshing has not

been identified. Ultimately, these scarce pieces of evidence do not appear sufficient to conclude that this type of activity took place at Mauran, particularly in view of the high numbers of hides to be processed. The presence of a few pieces of charcoal (from non-systematic sieving) suggests the collection of wood, for a purpose which has not been identified (heating, smoking / drying of meat). Some bones containing fat may have been used as fuel for hearths, as evidenced by the presence of burnt bone. Use-wear associated with the working of a wood-like medium-hard material are also rare; these were identified on approximately ten tools used for sawing or scraping. Therefore, no intensive exploitation of woody materials appears to have taken place, with these tools possibly indicating the procuring or construction of wooden structures for transporting hides or certain parts of the carcass. As at Les Fieux, evidence for scraping hard materials may be due to the scraping of bone before breaking them to retrieve the marrow, or to the manufacture or maintenance of hunting spears, directly linked to the procurement of game.

The functional data obtained for this industry, that is, principally of butchery, the absence or extreme rarity of hide working, and the low frequency of woodworking, therefore strengthen the hypothesis put forward by our predecessors of a site specialized in the slaughtering and primary processing of bison herds. It may be pointed out that for an equivalent surface area and a similar number of stone tool remains, the number of bison carcasses here is 4 to 5 times higher than in level Kdenticulates at Les Fieux.

Saint-Césaire (level Egpf)

The inhabitants of the rock shelter at Saint-Césaire established their settlement close to raw material sources, which were present on the plateau overlooking the shelter (Thiébaut *et al.*, 2009a). All of the elements of the *chaîne opératoire* were present, though with an underrepresentation of cores (Thiébaut, 2005). The procurement strategies resemble the *provisioning of place* model. The few blanks which were imported from approximately 10 km away, in very small quantities, were practically "swamped" by the numerous debitage waste products in local materials. It should be noted, however, that their presence may reflect the importing of blocks and blanks which would have formed a toolkit and a small reserve to be used by human groups as they traveled, indicating a *provisioning individuals* model. The existence of high quality raw material sources was not the only appeal of this site, as attested by the numerous faunal remains uncovered. The site was therefore not a knapping workshop *sensu stricto*. It is difficult to evaluate the proportion of unmodified or finished products exported, but the flakes of full debitage are present in reasonable proportions (Thiébaut, 2005). Lithic and bone material are very abundant in level Egpf, suggesting that this level may correspond to an accumulation of several residualized occupation layers (more than 140 000 bone remains and almost 47 000 lithic remains). Bison, horse and reindeer were hunted in relatively similar proportions. The zooarchaeological study (Morin, 2004) shows that the most nutritionally rich parts of the carcasses were brought back to the site, that they were processed on-site and that the marrow contained in the bones was collected. It should also be pointed out that a relatively large number of hearths were discovered (Backer, 1994), which went hand in hand with the use of bone as fuel (Morin, 2004). Before the results of the use-wear study, we had interpreted the archaeological level as the result of an accumulation of seasonal or long-term residential settlements (Thiébaut *et al.*, 2009a). However, the very small proportion of tools (27 from the 1 293 examined) which present evidence of use is, only partly, attributable to the poor level of preservation on certain working edges. The activity of cutting in butchery is largely predominant, accompanied by a few possible instances of butchery by percussion and two pieces having possibly been used to scrape bone or hardwood. Activities linked to the processing of plant and animal

materials were therefore not very diverse and not very intensive. There is no evidence of hide working. The limitations due to preservation problems on certain working edges are offset by the very large number of objects which underwent use-wear analysis. The scarcity of use-wear traces and the limited diversity of observed use-wear are therefore not the result, in our opinion, of taphonomic bias. The results obtained thus do not fit with the hypothesis of a residential site, even seasonal. How should the settlement at this site be interpreted? Two hypotheses may be proposed:

- the level is an accumulation of two types of settlements by separate human groups: a knapping workshop used by one human group and a seasonal settlement where meat resources were consumed by another group. However, as we have seen, there is no evidence for the exporting of finished products, while we have observed a lack of cores. This aspect therefore does not correspond with what is typically observable at a knapping workshop;
- the level is an accumulation of several seasonal settlements by the same group, related to a specific activity: the secondary processing of skeletal elements rich in marrow (long bones) and meat (fleshy parts). The small proportion of retouched tools which show signs of use (for butchery) and the low numbers of retouched objects overall, which suggests a low frequency of resharpening, may be evidence of a butchery activity which leaves few traces (i.e. limited contact with bone) or of the use of the tools for a relatively short duration. The presence of many hearths may indicate secondary processing of the meat (drying, smoking). Level Egpf therefore appears to reflect a settlement which was directly linked to the processing of meat resources with a view to their storage. A preliminary study carried out recently on a sample of bone from this level showed the presence of longitudinal cutmarks on the fleshy parts, which may imply the removal of strips of meat which would fit well with the idea of storage of the meat obtained (Soulier, Morin, 2016).

The second hypothesis seems to us the most plausible in light of the currently available data. Thus, the use-wear data obtained as part of the PCR enable us to imagine that the site of Saint-Césaire was used for secondary butchery, specialized in the conservation of meat-based food resources with a view to storing them. This hypothesis is corroborated by the recent preliminary results (Soulier, Morin, 2016) obtained on butchery cutmarks observed on the long bones.

B - Human group mobility

Following the results obtained in the context of this PCR, we can suggest that the technical objectives of Neanderthal knappers can, in rare cases, be simply correlated with the functional objectives of the tools (notches for scraping activities, convex side scrapers for working hides, flake cleavers for percussion activities). The various types of tools – side scrapers, bifaces, unmodified Levallois flakes, pseudo-Levallois points, denticulates – were used for diverse activities, with a predominance of butchery activities. Thus, the utilization of a debitage method or concept seems to be mainly guided by the knowledge, technical customs and cultural choices of human groups. The debitage methods employed appear, therefore, in our view, to reflect technical traditions which were specific to a cultural group. The presence of bifaces alongside different debitage concepts probably gives these types of tools a different value. These elements are more than simply a feature of a particular technical or even cultural group; they may reflect technical exchanges, finds, innovations and continuities shared by different groups within a given geographical space. We begin therefore by examining the functional status and the mobility of these bifaces, then, by way of comparison, that of flake cleavers, before proposing some mobility patterns for more homogenous technical groups.

a - The functional status of bifaces and human group mobility

Various attempts have been made at modeling the mobility of groups who practised biface manufacturing during the Middle Palaeolithic, based on the segmentation of the *chaîne opératoire* of the manufacturing of bifacial tools, in relation to their raw materials (Tavoso, 1986; Geneste, 1985; Turq, 2000; Soressi, 2002; Turq *et al*., 2017).

In the mobility model put forward by A. Turq (2007) for the Mousterian of Acheulean Tradition, several types of site are differentiated based on the presence or absence of bifaces and biface manufacturing flakes: 'A' sites were for manufacture (bifaces and biface manufacturing flakes), generally carried out using local materials, 'B' sites (only bifaces, modified on-site or not), and 'C' sites, which were temporary (only biface resharpening flakes), with varying proportions of objects made from non-local raw materials. This model effectively illustrates biface mobility, at times over long distances, with sites corresponding to a *provisioning of place* model (the bifaces were produced on-site using a local raw material and then taken away) and others identified rather as *provisioning individuals* (completed bifaces were brought to the site, used there and sometimes resharpened, then abandoned or brought away). Nevertheless, the function of these sites is probably more complex, and their identification requires the use of other data (use-wear, zooarchaeological, spatial). For example, A type sites may have been residential sites or knapping workshops. Similarly, even if a site was specialized in meat processing, based on the quantity of carcasses to be processed, the on-site manufacture of bifacial tools could easily take place in order to supplement the toolkit brought to the site. Only an interdisciplinary approach will enable us to distinguish a residential settlement from a settlement established for a more specific activity.

According to M. Soressi (2002), the temporal and spatial segmentation of the biface manufacturing *chaîne opératoire* observed at various sites and the frequent hafting of tools during the Mousterian of Acheulean Tradition "type A" (based on data from Anderson-Gerfaud, 1981, but which were not confirmed by our results) are evidence of a *collectors* type of mobility, which involved the existence of residential sites, from which logistical sites would have developed, for carrying out specific tasks such as hunting or procuring lithic or plant raw materials.

Richter's model (2001), which was based on the Micoquien industries from Sesselfelsgrotte has parallels with that of M. Soressi (2002). The bifaces appear to reflect a mobility which was specific ("radiating land-use pattern, during autumn": 206), characterized by the presence of base camps occupied for a long period of time. Here, we are dealing with a model similar to that of the *collectors*, during a limited part of the year. A. Delagnes and W. Rendu (2011) have proposed, for the Mousterian of Acheulean Tradition groups, a mobility pattern which is distinct from that identified for the Quina and Discoid-denticulate groups. This mobility appears to be associated with the practice of non-selective hunting. The authors also outline different degrees of mobility between the bifaces and the flakes produced during the debitage of blocks. In their view, flake production was focused on activities carried out at the dwelling sites, while the bifaces were designed to be mobile and therefore used on more specialized sites. These MTA groups would have occupied an "intermediary" position in terms of mobility, between, on the one hand, the Levallois and blade groups for which residential mobility has been proposed and, on the other hand, the Quina and Discoid groups, whose mobility was, according to the authors, seen as logistical. If we continue this line of thought, the biface therefore appears to have been a tool which enabled short-term logistical mobility (the *collectors* model) within a *foragers* organization.

The data obtained in the context of the PCR have contributed to reflection in relation to the functional status of these objects and have allowed for the mobility of the groups associated with them to be examined in a new light.

In view of the PCR's results, the modes of operation of bifaces are, almost exclusively, linked to butchery activities, including the most reduced forms (see Part II, chapter 4.4). However, these objects did not have a functional specialization, since flakes, side scrapers and denticulates also show traces of cutting during butchery, in other assemblages, but also within collections which include bifaces. The production of a biface was therefore in no way indispensable in order to carry out butchery, and it even required a specific knowledge, the use of particular techniques (soft hammer or hard hammer with a tangential motion) and raw materials of a certain quality. Their manufacture was therefore not the most straightforward response to a particular functional objective. The meaning of their presence within lithic assemblages must therefore be understood beyond the "simple" functional register. We can thus explore the practical aspect of these tools before examining their symbolic importance. Their longevity, related to the possibility of rejuvenating them numerous times before they lose certain morpho-functional characteristics necessary for their initial intended use (butchery), sets them apart from the majority of flake tools discussed above (with the possible exception of Quina side scrapers). This was a considerable advantage which probably explains their extensive mobility. As mentioned by various authors (Richter, 2001; Soressi, 2002; Delagnes, Rendu, 2011), this tool therefore appears to have been very well suited to logistical expeditions aimed at the specific procurement of principally meat-based resources, but also plant-based, depending on their morphology (bifaces with convergent edges versus bifaces with a transverse edge, see Part II, chapter 4.4). The use of certain bifaces as hammerstones (Claud *et al.*, 2010) and as strike-a-lights (Sorensen, Claud, 2016), which did not necessarily affect the cutting properties of the edge, enables us to produce a more comprehensive functional description of these tools. Lastly, the role of bifaces as sources of flakes must be mentioned, as evidenced by the use of biface manufacturing flakes (Chez-Pinaud), even though we cannot confirm the existence of intentional, recurrent and predetermined production of shaping flakes, as has been suggested by M. Soressi (2002) and J.-Ph. Faivre (2003).

The numerous technical and functional qualities and possibilities of these tools were undoubtedly related to their extensive mobility. However, the role played by raw materials in this mobility is also likely to be of importance. As Mousterian bifaces were often made from flakes, the initial block, in addition to being of good quality, needed to be of a relatively large size. These economic constraints therefore favoured the transport of such tools by traveling groups. The expertise and the technical constraints – of percussion – necessary for the manufacture of bifaces may have had a major influence on the long lifespan and the advanced degree of use of certain objects. These different aspects show that, beyond their practical and functional use, the underlying technical and economic constraints in biface production most likely influenced groups to choose to bring this type of object with them when they traveled (Brenet *et al.*, 2016).

Other Mousterian tools present characteristics which are comparable to bifaces and perhaps had equivalent or similar functions. This is the case for Quina side scrapers, which were sometimes bifacially shaped using a soft hammer (Soressi, 2004; Jaubert *et al.*, 2008) and whose manufacture also required quality raw materials and specific expertise, knowledge and techniques. Like bifaces, these appear to have had a relatively long lifespan thanks to multiple resharpenings carried out on them (Lenoir, 1986; Bourguignon, 2001; Geneste, Plisson, 1996), as well as a considerable mobility, which has been demonstrated in particular by archeopetrographic studies (see for example, Park, 2007). On some sites, they were also used as cores for the production of flakes (for example, Jonzac, US 22, Soressi, 2004), and at times, were subsequently retouched again to form side scrapers (La Quina, Park, 2007).

In other series and technical groups, the importing of preformed cores made from non-local raw materials, which allowed for tools suited to various activities to be produced, probably helped to make up for an absence of tools such as bifaces. Thus, in Discoid groups with pseudo-Levallois

points which did not contain bifaces, other technical choices were made in order to reach the same objectives. The absence of intensive resharpening of these tools, which would have led to drastic changes in the morpho-functional characteristics of their working edges (whether they were pseudo-Levallois points or denticulates) was probably compensated by producing greater numbers of tools suited for the intended functional objectives, and less dependent on economic and technical constraints than bifaces. Similarly, the role of hammers and retouchers was also carried out by knapped elements other than bifaces, such as flakes (with "pecked butts"), cores or unmodified blocks (Thiébaut *et al*., 2009a; Thiébaut *et al*., 2010b). Discoid debitage *sensu stricto* therefore appears to have been very well suited to extensive mobility by human groups (Thiébaut, 2013) and therefore to a logistical type of organization.

The transport and use of bifaces was therefore not the only possible solution, or the simplest to implement, to enable a group of people to adopt a *collectors* type of organization within a given territory. Thus, beyond their functional potential and their practical usefulness, and in light of the economic and technical constraints which they imply, bifaces held without doubt a symbolic status which was considerably stronger than that of simple preformed cores, which were, technically speaking, accessible to more people.

With the high mobility of bifaces being undeniable (Park, 2007), we will now focus on the different functions of sites where evidence of biface manufacturing has been identified, in order to discuss the mobility strategies put forward by our predecessors. Firstly, it is necessary to emphasize that, contrary to some of the authors cited above, we do not consider those lithic industries which contain bifaces as assemblages which are characteristic of a homogeneous cultural group. The heterogeneity of the concepts and methods of debitage associated with biface manufacturing (Soressi, 2002; Turq, 2000; Ruebens, 2013; Brenet *et al*., 2016; Faivre *et al*., 2017) must call into question the very existence of the MTA technocomplex (see *Introduction*). Beyond potential stratigraphic mixing which distorts any attempt to characterize a technical ensemble, as was recently mentioned and demonstrated for the MTA (Gravina, Discamps, 2015; Gravina, 2017), assemblages containing bifacial tools associated with different debitage concepts and methods do exist. In the context of the PCR, the series examined are, for the most part, from recent excavations, often of open-air sites, and without any stratigraphic mixing (Bayonne le Prissé PM1 and 2, Combe Brune 2, La Conne de Bergerac, La Graulet and Chez-Pinaud), or where the assemblages showed high technical homogeneity within the associated debitage (Fonseigner). Depending on the collection studied, the bifaces were accompanied by different production methods or concepts (Discoid *sensu stricto* and *sensu lato*, preferential Levallois, recurrent centripetal Levallois or uni- or bipolar Levallois). In our view, this diversity of debitage methods alongside bifacial manufacturing accentuates the special status of bifaces. This diversity shows the existence of distinct cultural groups sharing or exchanging objects or expertise, which would thus have spread across a relatively vast territory, going beyond the geographic context of the assemblages studied. Thus, in the following paragraph, we do not propose to model the mobility strategies of a cultural group, but to identify the mobility models with which bifaces may be associated.

The sites of Chez-Pinaud, Fonseigner and Bayonne le Prissé PM2 are regarded as residential sites (see above). This type of site is seen amongst both *foragers* and *collectors*, and it is therefore difficult to deduct a specific mobility model purely by demonstrating the existence of such sites. There is a need for further details regarding the duration of occupation at these sites. However, at the site of La Conne de Bergerac, the few bifacial tools which were imported and used, the on-site debitage of cores brought to the site partly preformed, and the retouched tools, suggest a residential type of settlement, but of a short duration (temporary site, seasonal dwelling) which could fit into a *foragers* model. The same may be true of the nearby site of Bout des Vergnes (Ihuel [dir.], in prep.; Courbin, 2017) which presents the same techno-economic characteristics and for which the use-wear

study demonstrated the presence of butchery carried out with bifaces and flakes, as well as the use of several bifaces as hammerstones and probably as strike-a-lights. Nevertheless, the generally little-reduced and still functional nature of the abandoned bifaces on these sites tends to indicate rather a *collectors* mobility, according to S. Kuhn (1989). It would appear that the theory of the accidental loss of tools, which could also have explained the condition of these objects when abandoned, can be discarded due to its extreme rarity in ethnographic contexts (Yellen, 1977b).

No biface manufacture workshops *sensu stricto* have been identified in our corpus, but this type of site does exist, for example at Le Basté (Deschamps *et al*., 2016). However, the site of Bayonne le Prissé PM1 resembles a knapping workshop oriented towards flake production. The few bifaces found at the site were abandoned after having been used for butchery or as strike-a-lights. They were therefore brought by a group traveling to the site, the principal function of which was the procurement of mineral resources. On this site, the arrival of a human group may have had a double objective ("embedded", *sensu* Binford, 1980): the procurement of stone resources and the use of a few tools (bifaces, flakes) for a specific activity (butchery). In parallel, the open-air sites of Combe Brune 2 and La Graulet, characterized by the presence of a few bifaces, sometimes accompanied by potential on-site flake debitage (though evidence for this remains anecdotal), and the scarcity of retouched flake tools, resemble specialized sites related to the procurement and potential processing of animal or plant resources. These types of sites, linked to the acquisition of specific resources (mineral, animal or plant) are more commonly identified in a logistical mobility model.

While the data from the PCR on assemblages which include biface manufacturing appear to correspond with a *collectors* type of logistical settlement pattern, with residential camps and specialized sites, they do not exclude a *foragers* settlement model. Indeed, the *foragers* model is not incompatible with the existence of temporary and one-off journeys to obtain specific resources (mineral, animal or plant). However, the *collectors* model integrates the notions of storage and planning of activities (returning to a same site in a recurrent manner to procure a specific resource), whose existence has not been demonstrated at the sites examined. Thus, purely on the basis of the available data, and particularly in the absence of bone remains at numerous sites, we believe that it is difficult to favour the association of bifaces with a *collectors* model.

b - The status of flake cleavers and human group mobility in southern Aquitaine

Unlike bifaces, the flake cleavers of the Middle Palaeolithic have been the subject of a limited number of publications. Since the second half of the 20th century, with the exception of the research carried out by L. Benito del Rey (1972-1973, 1976,1978, 1981, 1983), their function has been downplayed within the industries which contain them (Cabrera Valdès, 1983; Freeman, 1966, 1969, 1994); at times they were even simply considered variants of classic bifaces (Chauchat, 1985).

We must first underline the distinctive geographical feature of these tools. During the Middle Palaeolithic, they were only produced within a relatively small region, which stretched from the Asturias to the Hautes-Pyrénées. This has given them the status of a regional marker within the variability of the Middle Palaeolithic industries, thus distinguishing the Vasconian from other Middle Palaeolithic entities. However, the presence of bifaces alongside these tools meant that for a long time, these industries were seen as belonging to the MTA, whose geographical distribution covered, until recently, the Pyrenean mountain range (Soressi, 2002; Ruebens, 2013).

Beginning with their manufacture stage, these tools require that specific economic strategies be put in place. In fact, flake cleavers are the only tools for which a specific raw material procurement took place within the assemblages studied. They were systematically manufactured on grainy materials (ophite or quartzite, principally) while flint was never used to make them, even when it was available in abundance (for example at Le Prissé and Jupiter), and from large blocks. As with

bifaces, the *chaîne opératoire* of their manufacture and use was segmented in time and in space. However, this segmentation is different from that of bifaces and resulted from technical constraints specific to these objects. Unlike bifaces, flake cleaver production waste products (cores, flakes) have never been identified on the site where the tools were found. The manufacture sites of these tools were therefore systematically located away from residential types of settlement. Made using river pebbles, flake cleavers were probably manufactured on the alluvium of rivers, areas which contained large quantities of blocks of raw materials large in size, but which rarely allow for the preservation of this type of site.

The absence of resharpening of flake cleaver edge, which, by preserving the morpho-functional characteristics, would have enabled their longevity to be extended, is another technical constraint which had direct consequences for the mobility of these tools, as their lifespan was much shorter than bifaces or Quina side scrapers. However, we cannot rule out the possibility that they were recycled as cores, though this is difficult to identify (Benito del Rey, 1979; Zilhão *et al.*, 2016).

Flake cleaver modes of operation have only been partly defined due to the mediocre preservation of the edges of the archaeological remains, where only macro-traces were preserved. Thus, even though only traces of use for percussion have been identified, this does not mean that other modes of operation did not exist for these tools. Nevertheless, it seems that they possessed a specific functional status since no other tool type shows such frequent use-wear traces linked to percussion.

This type of activity has been identified on materials of a hardness comparable with that of wood, but also with bone. This indicates a type of primary procurement of plant resources (felling) which is rarely recognized in Middle Palaeolithic toolkits, but also, in relation to carcasses, an exploitation of these at the end of the *chaîne opératoire*. This therefore enables us to consider flake cleavers as tools which involved specific means of exploiting the environment and specific socio-economic strategies (Claud *et al.*, 2015). The main advantage of this tool type thus appears, in contrast with bifaces, to be of a functional nature. Nevertheless, unlike bifaces, with the exception of rock shelter sites excavated a long time ago (Abri Olha, El Castillo), where stratigraphic mixing is possible, flake cleavers are generally associated with Discoid debitage *sensu stricto*. This considerable technical homogeneity may give flake cleavers a particular cultural characteristic.

At a regional scale, flake cleavers have been found on sites which show various functions. They are generally present in small numbers, except at Abri Olha I and El Castillo, where they were very numerous. Unfortunately, the function of these two sites has not been reliably determined.

Several sites appear to have been short-term occupations, located close to sources of stone raw materials. The settlements of Bayonne le Prissé PM1 and Jupiter (Discoid *sensu stricto*) were flake production workshops which included, in parallel, the secondary activity of butchery (Colonge *et al.*, 2015). Analysis of the collection from Le Basté (Chauchat, Thibault, 1968), situated a few hundred meters from Bayonne le Prissé and Jupiter, reveals that this settlement was mainly focused on the manufacture of bifaces and retouched tools. The poor preservation of the remains unfortunately prevents use-wear analysis from being carried out. This nevertheless points towards open-air settlements which had possibly complementary functions at a local scale (Deschamps *et al.*, 2016).

Other sites, such as Grotte du Noisetier and Gatzarria, appear to have been residential settlements towards which the regional, and sometimes extra-regional, raw materials (Deschamps *et al.*, in press) converged. Data from Grotte du Noisetier depict a residential type of settlement, but one which was short-term, reflecting a *foragers* settlement pattern (see above). The site of Latrote (Bernard-Guelle *et al.*, 2010, 2014) may have had a similar function, linked with the presence of certain meat-based resources (substantial butchery use-wear traces) at a particular time of year. The importation of raw materials from far afield (~100 km), sourced in the area near Bayonne, clearly indicates the place from which the group who settled at the site came. Relatively frequent use-wear traces which demonstrate a variety of activities have been identified on the flint industry

(butchery, working dried hides, Bernard-Guelle *et al.*, 2010). Moreover, the establishment of the settlement on the top of a hill overlooking the Adour valley suggests that this site was involved in the acquisition of game. Latrote may thus have been a seasonal camp related to the presence of game at a specific period of the year, reflecting a *foragers* settlement model.

The interpretation of the various site functions and their techno-economic complementarity within a given cultural group enables us to put forward a hypothesis of a territorial organisation at the scale of the north-western side of the Pyrenees. We have observed a certain complementarity between the open-air sites on the plains (knapping workshops, seasonal settlements linked with the presence of a specific resource) and those in caves and rock shelters located in the piedmont plain of the Pyrenean mountain range (base camps or seasonal residential sites). Occupations appear to have been intensive and/or recurrent at sites on the edges of mountainous environments, while the sites on the plains were used for shorter and more specialized visits. Nevertheless, aside from knapping workshops, which may be found in both of the proposed mobility models, no evidence for the storage of plant or animal resources has been identified, in part due to the absence of preserved carcasses or woody materials at the principal sites. Thus, the *collectors* model cannot be proposed for these populations.

c - Quina groups

As this group is only illustrated by a single site, we are not in a position to propose a settlement model. We can nevertheless point out that the settlement at Les Pradelles, which was specialized in the processing of reindeer carcasses with a view to the storage of the meat, resembles a *collectors* model, related to a very harsh climate. Levels g from Peña Miel (a long-term settlement, Montes *et al.*, 2001), and 12 from Le Roc de Marsal (long-term settlement, Soulier, 2007), La Cueva de Prado Varga (a temporary settlement with several occupations, Navazo *et al.*, 2005) and probably Esquilleu (a temporary settlement, Baena *et al.*, 2004) have nevertheless been interpreted as resulting from residential settlements of varying permanence, though it is not currently possible to associate them with the *foragers* or *collectors* models.

d - Levallois groups

Data from the PCR were too limited to allow a settlement model to be proposed for this group, all the more so because the debitage methods were different depending on the sites analyzed. We can therefore only note the existence, within our corpus, of residential sites (Fonseigner, Bayonne le Prissé PM2), although the duration of occupation has not been determined, which could thus fit into either one of the proposed models (*foragers* versus *collectors*). The sites of Coudoulous and Puycelci (layer 1, Bourguignon *et al.*, 2001), which are considered as sites specialized in the slaughtering and processing of carcasses, implying the planning of activities and storage of meat resources, appear to favour the *collectors* settlement model. These sites therefore call into question the patterns previously suggested by A. Delagnes and W. Rendu (2011).

e - Discoid sensu stricto *groups*

In order to broaden our field of view on these groups, this discussion will include a number of assemblages containing Discoid debitage *sensu stricto* which have not previously been mentioned (Les Forêts, Brenet, Folgado, 2003; Champs-de-Bossuet, Bourguignon *et al.*, 2000; certain levels from Abric Romaní, Thiébaut *et al.*, 2012; Beauvais, Locht, 2004). While the petroarchaeological

study of the series did not reveal the movement of human groups over very large distances, it did not allow us to claim that these groups remained confined to geographically limited territories (Thiébaut, 2013).

From a typological perspective, as the main objective of the debitage was to obtain pseudo-Levallois points and blades with core-edge backs, which were used unmodified, the retouched material associated with this method is quite rare and is represented by notched tools (Mauran, Saint-Césaire, Abric Romaní, Champ de Bossuet, Les Fieux Kdenticulates) or side scrapers (Beauvais, Les Forêts). Regarding denticulates, the data from use-wear studies enable us to suggest that they probably simply resulted from the resharpening of edges which had been used unretouched, as was brought to light at Saint-Césaire (see Part II, chapter 4.4).

It is interesting to note that these groups evolved in very different environments: rather cold, open steppes as at Mauran, Les Fieux or even Saint-Césaire, and very cold, as at the site of Beauvais (Locht, 2004), but also in more temperate environments (Abric Romaní, Allue *et al.*, 1996), at times in mountainous areas, like Grotte du Noisetier. The fauna hunted were therefore different from one site to another and the raw materials used for tool production were also very varied (flint, quartz, quartzite, schists). Through its technical and economic characteristics, this debitage method may be perceived as a good means of overcoming any material, economic or environmental constraints and appears to have been a solution that was perfectly suited to the nomadic organisation of the lifestyles of hunter-gatherer groups (Thiébaut, 2013).

However, in certain cases, this was accompanied by heavier tools such as bifaces or flake cleavers, whose value may have been symbolic, in the case of the bifaces, and functional for the flake cleavers (Bayonne le Prissé PM2, Latrote, Les Forêts, Bout des Vergnes, Le Basté).

The functions of the sites associated with these human groups also provide evidence of diversity in terms of settlement: knapping workshops with secondary consumption (Bayonne le Prissé PM1, Champ-de-Bossuet, Jupiter), seasonal slaughter sites with recurrent occupation of the site over several years (Mauran), sites for processing meat resources, with recurrent occupation (Les Fieux, Saint-Césaire), residential sites (Gatzarria, Latrote), sometimes seasonal or short-term (Grotte du Noisetier, Abric Romaní levels K and E, Bout des Vergnes). Sites which attest to intensive wood- or hide-working activity are, however, missing.

Knapping workshops and residential sites without evidence for the duration of occupation may belong to either the *foragers* or *collectors* settlement models. However, the settlements at Grotte du Noisetier and Abric Romaní (levels K and E) appear to fit more with the *foragers* model, with a residential, but short-term, type of occupation of the site, not linked to the procurement or processing of a specific resource. It should be noted that both sites belonged to a rather temperate climate. Conversely, sites specialized in the slaughter or processing of meat resources reflect the planning of activities over the year and the exploitation of a specific resource, and the storage of meat resources fits better with the *collectors* model. The settlements at these sites took place in a harsher climate. Both mobility models are therefore present here, and may be linked with climatic factors.

C - By way of conclusion

At the end of this chapter, it is worth noting the substantial flexibility of Neanderthal groups, who, despite the considerable weight of technical traditions, were able to adapt their economic behaviours and mobility strategies according to environmental constraints. Indeed, the data acquired, despite the lack of palaeoenvironmental information, appear to indicate a closer link between the environment and the settlement strategies developed by various Neanderthal groups, than between behavioural patterns, thought to be different from one group to another (Delagnes, Rendu, 2011), and the modes of settlement. The few settlements that were specialized in the

slaughter of large numbers of carcasses or in the conservation of meat resources for storage were found in arctic or steppe climates (Coudoulous, Les Pradelles, Les Fieux, Saint-Césaire, Mauran). In harsh climates, Neanderthals may have developed a logistical type of settlement pattern (*collectors*) with a more marked seasonality of activities, directly related to a reduction in plant resources and the hunting of animals found in herds. Climate may have made storage a necessity for group survival. Conversely, during milder periods, groups would have moved according to a more residential model, linked to the exploitation of the environment close to the site, which would have contained a greater abundance of diverse animal and plant resources (Grotte du Noisetier, Abric Romaní levels K and E).

Our results support the hypotheses proposed by P. Depaepe (2009) as well as the results presented by numerous ethnologists and other researchers, which demonstrate that the organization of current and recent hunter-gatherer groups within a territory is to a large extent a result of climatic changes and the behaviour of hunted animal species (see in particular Kropotkine, 1902; Mauss, 1950; Testart, 1986, 2014; Victor, Robert-Lamblin, 1989; Cashdan, 2001; Collard, Folley, 2002).

It therefore appears that while cultural traditions dictated a large number of technical features, environmental and climatic conditions may have played an important role in the mobility strategies of prehistoric human groups in the context of the exploitation of a given landscape.